

SOME NOTES ON SMALLPOX.

THESIS.

BY J. H. LIGHTBODY, M.B. (VICT.)

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[1893]



SMALLPOX.

HAVING acted as clinical assistant for a few weeks last summer at the Metropolitan Asylums Board's Hospital Ships in the Thames under Dr. Birdwood, my attention was drawn to the study of smallpox; and his successor, Dr. Ricketts, having most courteously allowed me frequent opportunities of seeing cases and consulting the hospital reports, I have been led to record a few of my observations in this paper, though I do not wish to speak dogmatically after so slight an experience.

I purpose—1st. To give an account of some cases indicating the differences of the disease in the vaccinated and unvaccinated. 2nd. To attempt to show from the histories of some cases that smallpox is not actively infective until about the second day of the eruption. 3rd. To describe the various methods in which infection may be spread. 4th. To analyse 300 cases comprised in ten months during 1892, and give a short account of the smallpox outbreak in London in that year. 5th. To make some general observations on points of interest in smallpox which I have noted. 6th. To give the conclusions to which I have been led.

To Dr. Birdwood, who first suggested the idea of this Thesis to me, and to Dr. Ricketts, without whose kindness I should have been unable to write this article, my most grateful thanks are due. Dr. Colclough, A.M.O. at the Ships, has afforded me great help in suggesting points of interest to be worked out. Dr. MacCombie, Medical Superintendent of the South-Eastern Hospital, has kindly given me the benefit of his extensive experience of smallpox. My friends, Dr. Hastings and Dr. Brock, have been good enough to assist me in looking over the proofs. The nurses at the Hospital Ships have done all in their power to help me to gain information, and the patients themselves have willingly submitted to the most exhaustive inquiries as to their histories. Mr. Mann, of the M.A.B., has kindly lent me several of the Board's reports. The following works I have consulted:—

- Royal Commission on Vaccination, 1889 (still sitting). Three reports.
- Curschmann's article on Smallpox in Ziemssen's "Cyclopædia of Medicine."
- Dr. Birdwood's Theory of Smallpox; Guy's Hospital Reports for 1891.
- Metropolitan Asylums Board's Reports, 1884-91.
- "The Truth about Vaccination." By Ernest Hart.
- "Vaccination and Smallpox." By Dr. Edward J. Edwardes.

I.—SMALLPOX CASES.

1. *Hæmorrhagic Smallpox.*

A. H., male, aged 46, had initial symptoms on November 23rd, eruption on November 25th, and was admitted that day. He had been vaccinated in infancy; there was a doubtful revaccination 19 years ago.

On admission, he had a confluent rash on the face in its earliest stage, *i.e.*, it consisted of small red papules, so closely set together that the face looked almost uniformly swollen, and the slight irregularity of the surface was better to be detected by the hand than by the eye. A profuse small papular eruption covered his back, and there was much injection; the rash was less profuse on the rest of the trunk and arms, and there were a few papules on the legs. His temperature was 105 deg. F.

Nov. 26. The papules on the back, which before were pretty uniform, now showed considerable differences in size. There were several petechiæ, about a quarter the size of a split pea, interspersed among the papules, and both petechiæ and papules were seated on an erythematous base which disappeared on pressure.

Nov. 27. Purpuric spots of small size appeared in the skin, and there were hæmorrhages into a few vesicles which had formed. Hæmorrhage from the throat, (apparently tracheal), occurred in quantity; there was also some epistaxis and profuse hæmaturia. Sub-conjunctival hæmorrhages took place, and also a few larger ecchymoses into the skin.

Nutrient enemata were given every two hours, and were fairly well retained. With a view to arrest the hæmorrhages, Extractum Ergotæ Liquidum, one drachm, was given with fifteen minims of Tinct. Opii; and the Ergot was continued in thirty minim doses every four hours, but had no effect; and patient died during the night (*i.e.*, on the fourth day of the eruption), remaining conscious until a few hours before death. With the exception of the temperature on admission, which was 105 deg. F., it did not rise above 100 deg. during the rest of the time. The nurse in charge reported that he suffered from great restlessness and some delirium, together with a troublesome cough and dysphagia.

P.M. report. The fauces, uvula, tonsils and base of the tongue were of a dark slate colour from the presence of submucous hæmorrhages, and these were also seen to some extent, but brighter coloured, in the larynx and trachea. The lungs felt very heavy, and on their surfaces were dark subpleural hæmorrhages, the size of a pea. Blood-stained effusion occupied the right pleural cavity; the left lung was extensively fixed to the chest wall by adhesions. On section, the lungs presented some patches of pulmonary

apoplexy, the size of a Tangerine orange. The peritoneal cavity contained bloody fluid, and there were spotty hæmorrhages into the peritoneal coat of the intestine (small), and into the mesentery. Subpelvic hæmorrhages were present in both kidneys. Bladder not examined. On the trunk there was a fairly well developed and abundant vesicular rash. The vesicles were more or less hæmorrhagic, and there were a few large ecchymoses. The rash on the face was not well developed,

This was not a typical case of *Purpura Variolosa* ; for in that form there is little or no rash, and only hæmorrhages from the mucous membranes. In the above, the rash, though delayed, was in the vesicular stage when the patient died, and hæmorrhages had occurred into some of the vesicles. The hæmorrhages from the mucous membranes were well marked ; as were also their evidences as seen post mortem.

2. *Confluent Smallpox* (unvaccinated).

W. B., male, aged 57, farm labourer from Stone. Inoculated when a boy, never vaccinated. Infected by a lad in the same house, who afterwards died on the Ships.

June 16. He was seized with shivering, headache, backache and colic. Next day he took an aperient which acted freely. That day (*June 17*) the eruption appeared on the back of both wrists ; he first noticed it on his face on *June 19th*. In spite of his illness and the presence of the rash he continued at his work till *June 20th*, and was removed *June 21st*. He is a big, burly fellow and a hard drinker.

June 22. Very abundant large pustules on the scalp, neck, and face (where they are confluent). Vesicles abundant on the limbs, trunk, and abdomen. Traumatic hæmorrhages into vesicles over left hip. There is much wheezing in his breathing ; he coughs a good deal, and spits up much muco-purulent material. He also suffers from dysphagia, and a choking cough comes on when he attempts to swallow liquids. Face enormously swollen, lips protrude like those of a negro ; cheek and neck are almost on the same plane ; eyes nearly closed by the swollen lids. There is a thick eruption of smaller pustules on his neck.

June 23. Back thickly covered with pustules ; scabbing has started on the face, especially around the nose ; and the yellow paint (*Pulv. Cretæ Aromat.*) caking in great scabs with the contents of the burst pustules, gives his swollen red face a horrible appearance. There is a purulent discharge from his eyes. He breathes rather easier, and swallows with less difficulty. Constipation has been present since admission.

June 24. Breathing still remains rapid, laboured and wheezing ; there is not so much cough. He sleeps a good deal. Whole face is now scabbed. Till to-day his nose was blocked with crusting pustules, but it is now free. Over the limbs and body the eruption is generally pustular. Patient suffers greatly from thirst, his mouth is very sore, and he sucks ice constantly. Temperature 102·4 deg.

June 25. Up to to-day he has been "mazy," but now seems better and more sensible. Constantly murmurs that "he wants his dinner, cheese and ale ; hasn't had anything to eat for a month ; wants to get up and put his clothes on and go out, &c." Eyes

are less swollen, but there is some conjunctivitis. On abdomen and chest is a closely-set small pustular eruption beginning to scab. Pustules in soles of feet, which are a good deal swollen and painful; he cannot close his hands for the same reason.

June 26. Slept better. Temperature 102.6 deg. and rising. Hands muffled, as he scratches his face. Face flushed and dusky, and speech thick. In a few places on his arms the eruption has apparently aborted in the vesicular stage, and there are rounded, brown, shining, tough scabs lying almost flat on the surface, all the surrounding areolæ having faded.

June 27. He seems much better this morning, and is eating and sleeping well. Scabbing is general over the whole body. On the forearms there are a few thin-walled superficial pemphigus blisters containing clear fluid, and collapsing when pricked. Round the ankles linger a few shrunken late pustules. His cough is less, and he is quite rational to talk to, but rather dull in intellect.

June 28. Mouth very foul, lips and tongue covered with brown sordes. Underneath the tongue are the remains of burst pustules. Scabbing is taking place in the drying pemphigus blisters. Cough slight.

June 29. Last night his breathing became worse, and the delirium returned. As he couldn't take food by the mouth, nutrient enemata were administered, which he didn't retain. This morning he is unconscious, very restless, throwing the bedclothes off, rambling in his speech, and trying to get out of bed, so that he requires constant watching. He lies on his back with dusky flushed face and closed eyes, and cheeks that are puffed out at every expiration with a whiffing noise. The extraordinary respiratory muscles of the upper chest and neck are called into play, and tracheal râles are heard. Respirations, 50 per minute, shallow. Temperature, which on the morning of the 26th was 103.6 deg., went down that evening to 101 deg., and is now (mid-day) 100.8 deg. Pulse, 130, soft and compressible. He never regained consciousness, and died at 5.30 p.m.

The above was a good example of an unvaccinated case, with bronchitis and pneumonia following a confluent attack in an intemperate man who took no care of himself (for he worked in the fields till the fourth day of the eruption). The inoculation in childhood doesn't seem to have had any influence in modifying the course of the disease.

3. *Confluent Smallpox* (unvaccinated child).

E. R., female, age 5, from Charlton, near Woolwich. Has never been vaccinated. Infected by a neighbour's child with whom she played. *June 16.* She had a "fit," and the eruption appeared the same day on the face. She came to hospital *June 22.*

June 23. Late pustules and scabbing on face, confluent. Early pustular rash on trunk and legs; very thick on arms and back; scanty on front of trunk. There are pustules on the tongue and palate, palms and soles. Into the pocks on the shoulders and upper arms there are traumatic hæmorrhages. Some purulent discharge from the

eyes. Eyelids much swollen. Corneæ hazy; conjunctivitis. Boracic lotion and Atropine applied to the eyes.

June 24. Early pustules thick on scalp. Those on the limbs are very large. Eyes better; not so swollen, and discharge lessened. Traumatic hæmorrhages on buttocks. Slight cough. Temperature has risen steadily since admission, and is now 101·8 deg.

June 25. At 4.30 a.m. the child had a "fit"; lost consciousness, the face and limbs twitched, but there was no foaming at the mouth. Several petechiæ, about the size of a pin's head, were noticed in among the pustules on the lower part of the abdomen, inner side of both thighs, and the buttocks. Cough troublesome. Voice faint. Child very restless. Pustulation is ceasing, and scabbing occurs on the face and back. Some pustules remain round the wrists and ankles, with flaccid walls and lessened dusky areolæ. Eyes very sore, and almost closed up. Purulent discharge and conjunctivitis.

June 26. Temperature 105 deg. nearly all night, child very restless, with persistent cough. She takes liquid food fairly well. Arms and legs almost completely scabbed. The nose remains blocked. She lies on her back with her mouth wide open; respirations, 40, in short, shallow gasps, interrupted by occasional low moans. Arms thrown about wildly, with some tremor. Sponging has not reduced the temperature, so that, at 11.40 a.m., a wet pack was applied. At 3 p.m. the temperature was nearly 108 deg. F.; but she had become quieter after the pack. Breathing remained very hurried. Nurse reports that at 3 p.m. the pupils contracted, and about 4 p.m. the corneæ became hazy. At 5 p.m. tracheal râles were heard, and she gradually sank.

In contrast to the above case, I may mention those of her brother and sister, who were successfully revaccinated on *June 23rd* (a week after E. R.'s rash came out).

a. M. A. R. (sister), aged 7. Initial symptoms commenced on *June 24th*, and were probably due to the vaccination of the previous day. Eruption, *June 30th*. She had a greatly-modified discrete attack. Spots:—2 on right and 2 on left arm, 14 small ones on left leg, 8 on right leg, 7 on face, none on palate, chest, abdomen, back, palms, or soles. Some of these became vesicular, but none proceeded further in development.

β. S. R. (brother), aged 10. Initial symptoms *June 25th*, 2 days after vaccination. Eruption *June 30th*. He had an extremely mild attack, only 20 small papules altogether; and of these a few aborted in the vesicular stage, the rest remaining papular.

a. and *β.* had been vaccinated in infancy; they were successfully revaccinated on the 8th day of their incubation period, and escaped with such mild attacks that they were not confined to bed; their poor sister, who had never been vaccinated, had an extremely severe confluent attack with late petechiæ, and died on the 10th day of the eruption from pneumonia. *a.* and *β.* were examples of concurrent vaccinia and variola.

4. *Confluent Smallpox following Chickenpox.*

M. A. F., female, aged 2, from Greenwich. Was infected on board the Ships; not

vaccinated. *May 25th* felt unwell ; *May 26th* vomiting ; *May 28th* varicella eruption on face and back.

Three attempts were made aboard to vaccinate the child—viz., on *May 30th*, *June 1st*, and *June 4th*, but all failed.

She came in on *May 30th* with a vesicular varicella eruption, about 40 spots on the forehead ; many very small, commencing to scab. There were also some vesicles on the back, and a few in the soles.

On *June 2* there appeared a slight blush on the chest and arms, but as this faded by the next day it was probably a transient erythema. All went well, and the child sat up on *June 10th*.

June 11. The child being fretful and feverish, her temperature was taken, and found to be 102·2 deg. Tepid sponging was ordered when the temperature reached 103 deg., and was required at midnight, the temperature being 103·2 deg.

June 12. Sponging didn't bring down the temperature below 103 deg. till 6 p.m., when it was just over 100 deg. Fauces were noticed to be covered with white specks. Vomiting.

June 13. An eruption of very small discrete red variola papules occurred on the forehead, also well marked on the trunk, and most abundant near the hips. Temperature remains at about 100 deg. ; child is better and less fretful. There are a few papules on the palate.

June 14. The papular eruption, still small, is now abundant over the face, trunk, and limbs. Temperature completely intermitted. Child looks very ill.

June 16. She is extremely fretful and cries almost continuously in a loud voice except when nursed ; sleeps very little. No vomiting since the 12th, except once on the 15th. Hardly takes any food ; bowels constipated. Left eyelid very much swollen, but both eyeballs clear.

June 17. Hands muffled. She dozes continually, is not so fretful, seems weaker and her voice is fainter. Pocks on the face are very dense, and, having become vesicular, are now in most places confluent.

June 19 (7th day of eruption). Abdomen, back, arms, and legs covered with thick vesicular eruption, which is confluent in patches on the arms and legs, as well as on the face. Traumatic hæmorrhages on buttocks. Eruption less thick on the lower parts of the legs. Temperature, which has been steadily rising since the 17th, was 103·8 deg. at 6 a.m. to-day, but went down after a tepid bath. Child's face is very much swollen up, and eyes almost completely closed. She is much weaker, and evidently sinking. Food is refused, breathing irregular ; she is semi-comatose. During the night the temperature, which had sunk to 101 deg., began again to rise, and reached 101·8 deg. at 10 p.m. She gradually sank, passing away in the early morning.

In this case, an unvaccinated baby, suffering from chickenpox, was, by an error in diagnosis, sent to the Ships, and exposed to the contagion of smallpox, both on the way down in the ambulance steamer and on board. Three unsuccessful attempts were made

to vaccinate her. She got a confluent attack, from the severity of which, at her tender age, she died on the eighth day of the eruption.

5. *Confluent Smallpox* in a vaccinated child ; recovery.

C. M., female, aged 7, from Swanscombe, Kent.

Infection. She lives in the same row of houses as the B—— family, one of whom (S. B.) is now on the Ships. Another B—— child died at home of smallpox, and C. M. played with it during part of its illness. C. M. on admission was delirious, and this her mother attributes to the fright she got on hearing of her playfellow's death. C. M. also saw a good deal of another child (medically certified as smallpox), whose parents refused to allow her to come to the Ships.

Initial symptoms commenced on *June 12th* with headache, loss of appetite, and fever. That night delirium came on; the child screamed, beat her mother, jumped out of bed, and had visual illusions. This condition lasted till, on *June 14th*, the eruption appeared on her face. She was admitted on *June 17th*.

June 18. Face thickly covered with confluent papules and vesicles (mostly the latter), about 120 on the forehead. Numerous vesicles, especially on the backs of both arms and hands, confluent in places. On the legs there is a sparse distribution of discrete papules; none on chest or abdomen. Several vesicles on the tip and frænum of the tongue. Although vaccinated in infancy, she showed no marks.

June 19. On the face and arms there is a well-marked confluent vesicular rash. Child has not been delirious since admission, but is easily frightened. Complains greatly of headache. Eyelids swollen; there are some vesicles on the lids. Sight is somewhat dimmed.

June 20. She seems very ill, and lies apathetic in bed. Swelling of eyelids increased, and pus is escaping from the almost closed eyes, frequent washing out with boracic lotion being required. A few vesicles have appeared on the abdomen, and a copious vesicular eruption is present on the upper chest and round the shoulders.

June 22. Sleeps at intervals. Headache present, but not so severe. Temperature up to 102·6 deg. (8th day of eruption). On the face scabbing has commenced, the pustular stage there being soon over. The vesicles on the hands and arms are becoming pustular, especially in the confluent patches. On the back, a few vesicles occur; these are not greatly distended, and show umbilication well. On the whole abdomen there are only five small vesicles. In the palms and soles pustulation is going on in their numerous and deep-seated vesicles.

June 24. The legs have been painted with Pulv. Cretæ Aromat. and are generally pustular. Child breathes heavily. Has no cough. Feet very sore and much swollen. Face scabbing; it has been painted for six days, and this is now stopped.

June 25. Some pemphigus on wrists; also late pustules. Traumatic hæmorrhages into pocks on both palms and backs of hands. Face is clearing up, and

scabs falling off; it is greased daily. Swelling of eyelids has gone down, discharge ceased, and her sight is quite good. Headache better, no delirium, she sleeps and takes food well. Fed herself to-day with milk pudding.

June 26. Most of the pemphigus blisters have now dried up. Feet also dry and scabbing; swelling and pain are gone; a few late unareolated pustules remain round the ankles. Temperature for a week has oscillated between 100 deg. and 104 deg., and has now fallen to about 100 deg. Back is scabbed. She feels pretty comfortable, and has quite lost her old terror-stricken look.

June 27. Face is nearly clear of scabs, but there are still several on the body and limbs. A few of the pemphigus blisters remain round the wrists and ankles. Last night her temperature was nearly 105 deg.; the day had been very sultry, and she was doubtless over-excited, being a very nervous child. Some soreness is still present round the heels. She sleeps and eats well, and has no headache or constipation, from which she suffered so much at first.

June 30. Quite cheerful to-day and much better; she was able to have a bath, which gave her great relief. On some places on the arms where the scabs have come off too early superficial ulcers are left.

July 1. Tenderness and soreness of feet quite gone. Temperature down since the 26th, child practically convalescent.

This case shows the value of good vaccination marks, or rather that without good marks (indicating a successful vaccination) a vaccinated patient runs a good chance of getting as severe a confluent attack as an unvaccinated one. She had had a considerable exposure to infection; the neighbourhood where she lived was at the time a perfect hotbed of smallpox, and she was known to have played with at least two of the infected cases. Added to this was the shock of her playfellow's death, which the mother very reasonably considered as accounting for her delirium, though it can hardly be thought of as influencing the character of her eruption. A glance at the case of M. A. R., who was the same age as this child, will, I think, say much in favour of successful early vaccination and revaccination when a person is exposed to infection.

6. *Confluent Smallpox, 37 years after vaccination.*

W. L., male, aged 37, cabman, from Lambeth. Vaccinated in infancy, shows four good scars, 612 square inches in area, and all foveated. [For history of infection, see the end of this case.]

Initial Symptoms. *June 10.* He felt sick, had headache, backache, and limb pains.

June 12. In the afternoon the eruption appeared on the chest and arms, and a few on his legs.

June 14. He was admitted with papules and early vesicles confluent and crowded on his face, which is almost entirely covered with eruption. On the limbs occur several

discrete papules. Numerous papules on palms and soles and on palate. Eruption abundant on back.

His face was painted, and to relieve the skin irritation it was sponged with weak acetic acid.

June 15. He has been very restless and sleepless. Face greatly swollen. Severe conjunctivitis in left eye, and a hazy patch on left cornea; Atropine applied.

June 16. Nose blocked with pustules and their discharge; breathing is consequently impeded, and the voice nasal. On the tongue are several vesicles on the tip and under surface, also numerous ones on the palate, making the mouth very sore. Mouth painted with glycerine of borax. He swallows pretty easily, but suffers greatly from thirst, and is continually sucking ice. There is no itching of the skin. Eyelids are considerably swollen, so that he can hardly open his eyes at all. Vesicles on lids, and purulent discharge, especially from the left eye.

June 18. Eruption over face most profuse, confluent and pustular in most places, the pustules being of large size. Over the scalp are thickly-set early pustules. The painting of the face has caused some exudation and crusting.

Right arm painted. Eruption on hands is very thick, and consists of large early pustules, surrounded by bright areolæ which tend to run together. The pocks are semi-confluent, in little groups of two, three, five, or more, forming segments of circles. Palms show several late vesicles.

Right leg painted. Numerous late vesicles on the soles of both feet.

June 19.—Face covered with scabs of burst pustules and dried paint. The scalp pustules are smaller than those on the face. On the sides of the neck, beneath the angles of the lower jaw, are large patches of confluent pustules, which have a dead-white colour and flat surface. The neck is greatly swollen and very sore, but no enlarged glands can be felt. Nose and ears are full of pustules; in the latter they extend into the external meatus. Lips enormously swollen and everted, and covered with pustules and dry brown sordes. A thick discrete eruption of pustules covers the back, most of them are about $\frac{1}{3}$ th inch across, but they are not so large as those on the face. The left pupil is kept dilated with Atropine drops. Breathing rather more easy. He takes liquid food (milk, &c.) well, but great thirst continues.

He was considered so ill as to be put on the danger list.

June 20. Hands show late pustules, with flaccid walls and small livid areolæ. Numerous thin-walled pemphigus blisters are present on the arms, especially on the extensor surfaces of the forearms; some of these have burst. They are quite independent of the pocks, and are not to be mistaken for small confluent groups of pustules. Some occur round the pocks and raise up on their surfaces two or three pustules each; others occur between the pocks, and bear no relation to them; they are very superficial.

On the legs (extensor surfaces) below the knees, and also on the dorsum of the feet and over the toes, there are, in this case, also these blisters.

June 21. Eye troubles are very acute; the left eye being principally affected;

there is intense conjunctivitis, but the cornea is clear, the whole eye is very much injected, and there is photophobia and lachrymation. Warm compresses to left eye.

June 22. Patient has slept well for the last day or two. His temperature, which has been over 101 deg for the last three days (6th, 7th, and 8th of the eruption) is now almost normal. Menthol (one drachm to one ounce of olive oil) has been given since admission as an intestinal antiseptic; it was stopped to-day, as was also the painting of the right arm.

Scabbing complete over face and neck; swelling of both considerably diminished. Pustules on hands show traumatic hæmorrhages, and now begin to dry up. A similar condition persists in the soles of the feet. The painting of the right leg has had no apparent effect in aborting the eruption; both legs are now in the late pustular stage. On the eyelids the pustules have burst, and are now scabbing. The lids are less swollen. A saturated solution of Boracic acid is frequently used to wash out both eyes. Left conjunctiva still greatly inflamed; cornea steamy, tending to opacity; sight defective in that eye. "Golden Ointment" (Ung. Hydrarg. Oxid. Flav.) used for last two days is now stopped, and Atropine resumed.

June 23. Face clearing up, and scabs coming off, leaving faint, dark-red papular elevations; nose free; he breathes well. Drying up of pemphigus vesicles on arms, leaving large flaky scabs which look not unlike psoriasis. Feet for some days have been so swollen, œdematous and painful that he can hardly bear the pressure of the bed-clothes on them; they are now easier. There is, however, considerable pain in the sole pustules, which, bound down as they are by the unyielding hard skin of the surface, exercise all their pressure on the subjacent sensitive nerve-endings. Feet are wrapped up in cotton-wool. A few unbroken blisters are to be seen on the legs, but most have burst and dried up. Pocks have come off the palate, leaving shallow dark-red ulcers. Painting stopped to leg and face; iodoform and vaseline applied to the latter, this acts as an antiseptic emollient and loosens the scabs. Patient sleeps now most of the day and night; he feels more comfortable; mouth not so sore, and thirst abated. Nitrate of silver solution, $\frac{1}{2}$ grain to the ounce, is applied thrice daily to the left eye.

June 24. A few late pustules on wrists and ankles; hæmorrhagic pocks in palms are smooth and hard, and reddish-brown in colour. He feels cheerful, has taken solid food for two days with good appetite, and "the pain of his swollen feet is all that troubles him now." Constant iced compresses are applied to the left eye.

June 25. Face almost clear of scabs, still kept greased. A few superficial ulcers left on the legs after pemphigus. Left eye less painful, and conjunctiva not so injected. For the last three days the lid swelling has steadily decreased. An opaque corneal ulcer is present at the site of the old opacity on the left eye.

June 26. Improving daily. Can now sit up in bed and feed himself. Conjunctivitis in left eye decreasing under treatment; a second ulcer has appeared on this cornea.

June 27. Face practically clear of scabs. Arms completely scabbed. Feet still remain tender and œdematous, and some œdema is present over the lower parts of the

shins. A few sore places between the toes, arising from burst confluent pustules, require dressing. Both abdomen and back are covered with scabs, which are coming off; he has worn a salicylic wool jacket lately to protect the back from the effects of pressure.

June 30. Feet not so sore. Œdema of ankles and shins less. Some small abscesses around the left heel were opened to-day.

I didn't see him after this, but his notes say that he got well gradually without further complications, except some troublesome boils, though it took him a long time to recover his strength. He left the Ships on July 23rd, after a forty days' stay. Two large opacities remaining on his left cornea the day he went out, Dr. Birdwood advised him to attend the eye wards at Guy's Hospital, which is pretty near to where he lives.

History of Infection.—This is interesting, as showing how contagion is conveyed and also the effects of recent vaccination in modifying the disease.

a. His son, W., aged 14, came to the ships with a discrete attack on Derby Day (*June 1st*), having had the eruption out on him since *May 27th*. R. M., female, aged 20, keeps a laundry, and this boy fetched his master's clothes to and from there; R. M.'s smallpox eruption came out on *May 5th*.

β. M. G., daughter of patient, aged 16, slept in the same room as W. for some nights during his eruptive period; her rash appeared on *June 9th*, she was successfully revaccinated on *June 1st*, and had a modified attack.

γ. A., another daughter, aged 11, was attacked with initial symptoms and the rash on *June 3rd*, she was revaccinated successfully on *June 1st*, and had slept for one night in her brother's room during his illness; she had only twenty abortive pocks altogether.

δ. F., son, aged 4, had not been revaccinated since infancy; his spots appeared on *June 9th*, and he had a modified attack. It appears that he did not sleep in the room with his brother.

β and *γ* are examples of concurrent variola and vaccinia.

ε. W. L. (the father, and present patient) had not been vaccinated for 37 years; he saw his son while ill, but didn't sleep in the same room, so that his exposure to infection was not so great as that of either of his daughters; nevertheless he was seized with the eruption on *June 12th*, and had a very severe confluent attack, which kept him in hospital for six weeks.

Following this came a crop of boils, and his intense conjunctivitis left him with two large opacities on his left cornea, in spite of the most careful treatment.

It is rather curious that a man, "protected" by such good scars, should have had so severe an attack. Though, in the main, good scars mean at least modification of the disease, if not absolute immunity, here was a man who had practically as severe an attack as an unvaccinated person. His case affords one out of many examples of the "wearing off" of the vaccination protection in the course of years, but this time is very

variable. Some persons much longer after vaccination, and with poorer scars, have their attacks modified; others, ten years or less after vaccination, may have a severer illness than this patient, and it may even prove fatal.

Since writing the above, I have heard of a remarkable case, which, as it bears on the point referred to, I shall mention here. A friend of mine, a hospital Sister, was vaccinated in infancy, and revaccinated at the age of 23, in consequence of an outbreak of smallpox in her family. Five of her sisters were attacked, and two died (one of these had been revaccinated a few weeks previously). Her own revaccination "took," she having a very sore arm and scars, but within six months she had an attack of confluent smallpox, of which she still bears the marks. Such an occurrence is fortunately rare, but there is little wonder that she is not a very firm believer in vaccination.

7. *Confluent Smallpox and Uræmia*, showing delay in the appearance of the rash.

G. B., male, aged 46, vaccinated in infancy, was in a London hospital with chronic Bright's disease when he contracted smallpox from a fellow-patient, who was removed to the Ships from the same ward.

Initial symptoms appeared on *December 3rd*, and the eruption on *December 5th*. He was admitted on *December 6th*, when there was a thick rash of early papules on his face, trunk, and arms (confluent on the face); the legs were free from eruption.

Dec. 10 (i.e., on the 6th day of the eruption), the rash is only now becoming vesicular on the face and arms, and that only in a few places. For three days after admission his temperature was between 102 deg. and 105 deg., and he suffered from uræmic delirium.

On *Dec. 10th* his highest temperature was below 100 deg., and it remained mostly subnormal till the end.

Dec. 11. Hiccough was very severe, and there was some vomiting. Gradually uræmic coma supervened, and he died next day.

This case is principally of interest in showing that some other diseases occurring together with smallpox delay the appearance of the rash. Usually, vesiculation takes place on the third day of the eruption; here it was only commencing on the sixth day, and was even then very incomplete.

8. *Discrete Smallpox (severe), vaccinated.*

W. B., male, aged 26, cabman, from a model dwelling in Shadwell.

Initial symptoms.—*June 11th*, headache; *June 12th*, shivering and nausea; *June 13th*, backache; *June 16th*, eruption; *June 17th*, admission.

History of infection.—This is very indefinite. He says that a few years ago there

was an outbreak of smallpox in the buildings where he lives. About ten days before his attack, he spent some hours searching for work in the courts and alleys of Kennington. (From Kennington, Lambeth, the other cabdriver, W. L., comes.)

June 18. Eruption papular, becoming vesicular, thickly set on the face, about 120 on the forehead. None on tongue, but several vesicles on the palate. Numerous papules on the back. Fewer on chest and abdomen, but papules more numerous on arms and legs; some also present in soles and palms. He was vaccinated in infancy, and has two marks, one being well-defined and the other not.

June 19. Face has been painted; this caused great smarting and a feeling of heat. Face thickly covered with large discrete vesicles; some on each of the swollen eyelids. Tongue has vesicles only on the left side; there are several on the palate, also on the ears and nose. His mouth and throat feel very sore. Last night he slept a little, and fairly well during yesterday.

June 20. On the neck the vesicles are set thick, and there is great swelling and tenderness, but no glands are to be felt. He can swallow all right, but movement of his jaws is painful. Though the vesicles on his lids make his eyes sore and watery, the eyes are clear, and the sight unaffected.

On his hands the clear wall of the vesicles are becoming opaque in their centres; there are sixteen on the left, and three on the right palm. There are some vesicles, not greatly distended, on the soles of his feet. The small confluent patches on his face are in groups of three, five, or seven. On the abdomen is a vesicular eruption, more plentiful than usual.

June 21. The palatal vesicles have burst, leaving soft white spots (looking like small sloughs). Several vesicles exist on his lips. The eyelids are less swollen. General eruption is becoming pustular. On the penis and scrotum are several late vesicles; some are on the prepuce, and others around and just inside the meatus. Legs show some confluent late vesicular patches, especially one on the inner side of the right thigh, measuring 3 inches by 1 inch. A copious rash of discrete pustules covers the back; some of these have burst or become hæmorrhagic from pressure.

June 22. Menthol administration and face painting were begun on the 18th. Head-ache of past few days is better. No cough. Face less swollen. Hands and feet very painful, on account of the distended pustules. There is scabbing around the mouth, nose, and neck. Some of the eruption below the eyes has aborted in the papular stage; in other cases only the top of the papule has become, first vesicular, and then pustular. Mouth still sore; swallowing unimpaired.

June 23. Paint and menthol stopped. Eyes have been unaffected throughout. Lid pocks have now scabbed; swelling of lids gone down. On the neck there is general scabbing and lessened swelling. Face covered with paint-crusting and burst pustules. Arms: round the wrists and back of the hand the pustules are at their height, the largest being $\frac{3}{20}$ th inch in diameter in all directions; they are hemispherical and very tense, but the surrounding areola has lessened and become darker in colour. Some are

confluent in patches of 3, 5, or 7. Forearms show scabbing, especially on their extensor aspects. Nose till now blocked; clear to-day.

June 24. Temperature fell to-day (9th day). On parts of the face the scabs have cleared off, and pink papules remain. On the chin, nose, and cheeks these papules are more raised and larger; some are still covered with scabs. Temperature 99·2 deg. Patient feels well, sits up in bed, and eats solids. The deep-red, slightly depressed ulcers on the roof of the mouth show where the former pocks were.

June 25. On the legs, the buttocks and outer sides of thighs have scabbed. A raw surface, beginning to scab, marks the burst confluent patch on the right thigh. Above and below the knees and round the ankles are a few shrunk pustules; scabbing over shins and other parts of legs, back, chest, and abdomen. Late pustules on backs of hands; rest scabbed. He has no pain; but there is considerable itching of his head and chest. He feels well, and is eating chicken to-day. It took him, however, nearly a month to get completely well, and for his feet and hands to lose all their pocks.

Compared with the other cabman, W. L. (who was in the same ward at the same time), this man, with ill-defined vaccination marks, got off with a severe discrete attack without any complications; but I have seen cases in the unvaccinated which have been no worse than W. B's.

The general characters of the two eruptions, except of course in those parts where W. L's was confluent, were similar; in both the vesicles and pustules ran a regular course and were of large size; but the present patient escaped the pemphigus, the subsequent boils, and the persistent eye troubles, which probably would end, even under the most favourable conditions, in impaired vision for W. L. in one eye.

9. *Discrete Smallpox* (modified).

W. G., aged 28, male, boot-finisher, from Whitechapel.

Infection.—A child from the same house (E. F.) came to the ships with smallpox on *May 17th*. Patient's wife, infected doubtless from the same source as himself, was admitted *July 2nd* with Hæmorrhagic Smallpox, and died on the 5th day. She had a papular hæmorrhagic attack with menorrhagia and hæmoptysis; was vaccinated in infancy, and aged 20. The child mentioned above was unvaccinated, aged 2, had a severe discrete attack, suffered from conjunctivitis and boils, and was in hospital over ten weeks. W. G.'s initial symptoms commenced on *June 15th* with headache, *June 18th* there was shivering, and on *June 20th* the eruption appeared on his right wrist and face. He was vaccinated in infancy, and had four ill-defined marks.

June 20. On admission, there is a discrete papular rash, the papules being largest and most numerous on the face, one or two large umbilicated vesicles occur on the right wrist (where the eruption first appeared). On the arms are sparse papules, a few $\frac{1}{5}$ th inch across, others $\frac{1}{10}$ th inch, and most not more than $\frac{1}{20}$ th inch. No eruption on palms.

Legs and chest have a sparse eruption ; very few and small papules on the abdomen. A few papules in the soles of the feet ; five on the palate.

June 21. Eruption generally papular, becoming vesicular. Umbilication of some parts well-marked, especially on the arms. Vesicles have appeared in the palms ; one on the right and three on the left. A few cover the ears, one or two on the eyelids ; a few scabs about the chin.

June 22. Face shows fairly numerous vesicles and papules. Occupying the points of many of the acuminate papules are minute vesicles. Several vesicles occur on the scalp. There is a pretty thick rash around the ankles of flat-topped papules commencing to vesiculate. A discrete eruption of vesicles occupies the chest ; while on the abdomen there are only twelve. A dense eruption, mostly papular, covers the back ; the papules are small, mostly $\frac{1}{20}$ th inch across, some $\frac{1}{10}$ th inch ; the few vesicles are flattened ; the grouping in parts of circles is well shown. Generally speaking, vesiculation is increasing. He has slight wandering delirium, and during the first few days of his illness suffered from profuse sweating.

June 23. The face having been painted, the surface feels rough from the mixed exudation and dried paint. The small vesicles on the acuminate papules have become pustular ; sometimes two or three of these pustular points are situated on one large, fleshy-looking, raised, reddened papule.

Many of the spots on the arms are extremely minute, and a large number of them remain papular. Headache and constipation for the last two days.

June 24. Scabbing has now taken place on the face and neck. The vesicles on the arms are larger and appear to be more numerous ; still several pocks are aborting in the papular stage. Headache gone ; he doesn't feel at all ill.

June 25. Some of the larger vesicles on the arms are considerably distended and their areola is marked ; umbilication has disappeared in them. Vesicles on feet are drying up and scabbing. Face painting stopped. He now takes fish or chicken.

June 26. Face completely scabbed, and the acuminate pustules have dried up. Neck scabs peeled off. On the arms, nearly all the vesicles have scabbed without pustulation ; and a similar condition prevails on the legs, these are mostly scabbed, though a few loose-walled vesicles remain. Pocks, hæmorrhagic in feet. The sparse abdominal vesicles have scabbed ; on the chest the vesicles vary from $\frac{1}{20}$ th inch to $\frac{1}{40}$ th across, and there are a small number of pocks in the pustular state.

June 27. Most of the scabs are off the body. He feels well, has been up for two days, is on full diet, and all headache and pain have gone for some days.

June 28. Face quite free ; a few scabs linger on arms.

This case shows modification of the disease even 28 years after vaccination which has left poor scars. Very few of the pocks reached the pustular stage at all ; most of those which did so were on the acuminate papules. The largest number aborted in the vesicular stage, several didn't go beyond the papular. He had no complications, if we except the headache and slight transitory delirium, and was up and taking solid food on

the sixth day of the rash. By the ninth day all the scabs were off his face ; and a few on the arms, hands and feet were all that were left. The vesicular stage came on earlier than usual (morning of second day) and lasted four days.

10. *Modified Discrete Smallpox.*

C. W., male, aged 45, bricklayer and house decorator, from Shoreditch. Vaccinated in infancy ; revaccinated unsuccessfully *June 25*. *Initial Symptoms*.—*June 17* headache and backache ; *June 18*, nausea ; *June 22*, sore throat ; *June 23*, eruption on the face, admitted same day. *History of Infection*.—His son G— was attacked on May 18th, his wife on June 1st, his daughter on the 14th, and he himself on the 17th ; from his family a girl living next door took it on the 21st.

June 24. On his face are several small acuminate pustules on a papular base, especially on the nose and chin ; altogether about 40 on the forehead. Hands, four papules in each palm ; on the arms is a sparse vesicular rash becoming pustular. Chest shows a few vesicles, hardly any on the abdomen. On the prepuce and glans penis are burst vesicles. Each leg shows only about a dozen small vesicles, except for a patch on the left calf, where there is a group of 20 early pustules. Six vesicles in each sole. Eyes free ; a few vesicles on palate.

June 26 (fourth day of rash). Most of the acuminate pustules have dried up ; the larger pustules show a bright areola. Arms and legs in early pustular stage ; on the back, from pressure, the pustules have burst and are scabbing.

June 27. The few pustules on the face have increased in size, and feel more sore ; the scalp is also tender from the same condition. Deep-seated pustules in the palms prevent him from closing his hands, which he holds semi-flexed. Most of the chest pustules (which have all along remained small) have burst. Legs show medium-sized areolated pustules.

June 28. On the face, scabbing is general. A few large inflamed pustules still on arms.

June 29. Scabbing commenced on arms. He went out on July 15, having suffered no complications.

Though this man had a pretty severe discrete attack, which attained in most places to the pustular stage, still his must be considered to be a modified case. Several of the face papules only pustulated at their points, as in Case 9 ; the vesicular stage was hurried over ; and pustulation on the face and arms commenced on the second day (which is remarkably early). Scabbing became general on the face on the sixth day (usually it occurs on the tenth day). Even on the fifth day he was sleeping comfortably, and taking his food well, and only remained three weeks in hospital. It is not contended that his illness was so modified as that of W. G. (Case 9) ; but the latter was only 28, while he

was 45 ; both having been vaccinated in infancy. This patient's revaccination, on the third day of the eruption, was, as might be expected, unsuccessful.

Of the other members of his family, his son, aged 16, vaccinated, had a discrete attack followed by conjunctivitis and corneal ulcer ; his wife, aged 48, vaccinated in infancy, had a modified attack, as had also his vaccinated daughter, aged 11.

11. *Greatly-Modified Discrete Smallpox.*

L. G., female, aged 13, from Shoreditch ; she lived next door to C. W. (Case 10), and contracted the disease from his family. Had three good vaccination marks ; not re-vaccinated.

June 21. Initial symptoms commenced with headache, backache, nausea and pains in the limbs, she also had "convulsions" (to which she is subject.)

June 22. Eruption appeared.

She had twenty under-sized spots on her whole forehead. Some of these aborted as papules, others scabbed after becoming vesicular. On the chest were six pocks, none on the abdomen, a few on the back. The arms showed a small and very sparse rash. On each leg were five papules below the knee, none above ; five on right foot and one on left ; right palm had three ; left two. None on palate or tongue.

This is an example of a very small amount of under-sized eruption, which aborts in the papular or vesicular stage, and causes the patient little or no inconvenience (I believe she was not kept in bed for more than a very few days), occurring in a girl who has been freely exposed to infection (next door there were at least four cases, and she played with the children), and who has not been vaccinated for thirteen years.

12. *Two Sisters' Cases Compared*, showing the protective influence of good early vaccination.

a., aged 29, had three good primary vaccination scars. Her eruption was sparse throughout, and various-sized, but none of the pocks were more than $\frac{1}{20}$ th inch in diameter, and some were mere macules. Most of it aborted in the papular stage, and the vesicles which were formed never grew tense, but soon dried up. Beyond slight sore throat she suffered very little inconvenience.

β., aged 24, had no vaccination scars, although she had been vaccinated in infancy. Her attack was a severe discrete one, almost confluent ; the face being swollen so as to be unrecognisable, and there being otorrhœa and conjunctivitis. The pocks were large (about $\frac{1}{5}$ th inch in diameter, or more), were uniform in size, and went through their regular course to pustulation. Indeed, as regards the type of the disease, it greatly resembled an ordinary discrete unmodified case.

13. *Modified Discrete Smallpox followed by Scarlet Fever.*

A. W., male, aged 7, from Shoreditch, vaccinated in infancy, four good scars with collective area of .84 square inches. Revaccinated unsuccessfully on *June 1st*.

Initial symptoms.—*May 25th*, headache, backache, pains in limbs, shivering and vomiting.

May 29. Eruption appeared on his face. It was a very modified attack which aborted in the vesicular stage; there was a sparse eruption on the face and trunk (only about twelve pocks), and next day one pock appeared on one of the soles.

On the third day after admission (*June 4th*) he was allowed to sit up, having been put on ordinary diet the previous day. All went well till *June 14th*, when there was a rise of temperature to 102 deg., with vomiting and sore throat; the palate and throat were very red.

June 15. Temperature has risen to 103 deg. A scarlatiniform eruption appeared on the trunk, principally on the back. Fauces much congested and swollen. Enlarged glands under angle of jaw. The child was at once isolated, throat painted with boro-glyceride, and chlorate of potash lozenges given.

June 16. At 2 p.m. the temperature reached its maximum, being 104.6 deg., and the eruption was a typical scarlet one (punctate erythema), fading on pressure. Yesterday the rash was distributed over the lower abdomen (Ilio-pubic triangle), and thence in two upright columns over the ribs to the axillæ, the whole distribution being roughly U-shaped. To-day the whole chest and abdomen are covered, and the eruption is very thick on the neck. It runs into confluent patches over the pubes and thigh flexures, and also round the knees and elbows. It occurs also in coarser spots, but thinner distribution, down the extensor surfaces of the legs. There is no rash on the face or forehead, or on the flexor surfaces of the arms. Throat is sore, injected, and swollen; neck swollen and tender. Boy is very restless and moans, lying on his back with flushed face, and looking very ill. Swelling of nares and muco-purulent discharge. Tongue furred, mouth dry; thirsty. Hot compresses applied to the throat.

June 19. Throat less swollen and red. He can swallow well; no return of fluids through the nose. "Strawberry" tongue. Temperature, 101 deg. at midday, fell in the evening to normal. Eruption has become dusky, especially on the trunk. Neck still swollen, but less painful.

June 20. He looks very pale and exhausted; is otherwise doing well. Rash almost completely faded from body; some remains on legs. Desquamation has commenced round the neck, also about the feet. Tongue clean but reddened. No albuminuria.

June 21. Peeling going on on groins and lower abdomen. Fauces congested, but much better. Transferred to South-Eastern Fever Hospital.

I have given this case because it is an instance of another acute specific disease com-

mening on the sixteenth day of a smallpox attack—*i.e.*, when so mild an attack was nearly over. A point of great interest in diagnosis seems to me to be the occurrence in this case of the scarlatiniform eruption in the Ilio-pubic triangle, and its extension up to the axillæ. These are the positions mentioned by most medical writers as being especially selected by the initial rashes of smallpox, and I venture to think that if this boy had not just recovered from an attack of smallpox, the scarlatiniform eruption first seen in this case would by many observers have been diagnosed as one of early smallpox.

Summary of the foregoing Cases.

1 is a fatal case, with hæmorrhages from the mucuous membranes and into the vesicles, and delayed rash.

2 and 3 are fatal confluent cases, in a middle-aged man and a child respectively, both unvaccinated; the former was delirious, both had pneumonia. A sister and brother of 3 had very mild attacks after successful revaccination.

4 shows a fatal confluent attack following varicella in an unvaccinated child.

5 is confluent in a vaccinated child with poor marks.

6 is confluent with eye troubles, 37 years after vaccination.

7 shows delayed rash in a man suffering from chronic Bright's, who was attacked with confluent smallpox and died of uræmia.

8 is an example of severe discrete, 26 years after vaccination.

9 indicates a modified attack, the eruption mostly aborting in the vesicular stage.

In 10 the disease is modified, as the course of the eruption is hastened: not so mild as 9.

11. A greatly modified attack in a vaccinated girl freely exposed to infection.

12. Two sisters' cases are contrasted, showing the protection of good vaccination marks.

13. Attack of scarlet fever coming on during smallpox convalescence; eruption resembling one of the initial rashes of smallpox.

II.—CASES ILLUSTRATING WHEN SMALLPOX PROBABLY FIRST BECOMES INFECTIOUS.

Most authorities state that smallpox is not only infectious in the eruptive stage, but during the initial illness, and even in the incubation period. My attention was first directed to the inquiry as to whether this is the case or not, after reading a paper by Dr. F. Colclough, assistant medical officer at the hospital ships, which appeared in the *Lancet* of October 1st, 1892. I have since investigated, independently, the following cases in the winter of 1892-3.

1. J. W., male, aged 41, living at Abbeywood. He works at the sewage works at Crossness, being employed in a gang with three other men, sometimes outside, and sometimes in the main sewer cleaning the gates. His home is about two miles from Erith, where some cases of smallpox have arisen lately. Living with him are his wife, aged 40, vaccinated in infancy, and his two children, both girls, aged 7 and 10, vaccinated in infancy, and going to a neighbouring Board school till *January 12th*.

Patient was taken ill between 10 and 11 a.m. on *January 8th* with headache and backache, while working on a twelve hour shift, but didn't return home till 6 o'clock that evening, when his time was up. [From *January 2nd to the 4th* he was holiday-making; but was at work on *January 5th, 6th, 7th and 8th.*] On *January 9th*, still feeling ill, he went on the mid-day shift from 2 p.m. to 10 p.m., but was too ill to resume his employment on the *10th*. On the afternoon of this day, at 4.45 p.m., the rash appeared on his forehead. Throughout his illness his wife nursed him; she didn't go to bed, but sat by his bedside. Both his children saw him night and morning until the doctor was called in on *January 10th* at 1 p.m.; when, as he had a cough, dyspnoea, and constipation, castor oil was given him, and a mustard plaister, followed by linseed poultices, applied to his chest. Three hours after the doctor's visit the rash appeared. Although the doctor didn't consider the case to be smallpox when he first saw it, the children were not allowed to go near their father, and only the patient's wife attended to him.

Next day, *January 11th*, the rash being pretty well out, the doctor diagnosed chickenpox, and only on *January 12th* he thought it might be smallpox; this was confirmed on the visit of the Medical Officer of Health at 11 a.m. on *January 13th*; patient was removed to the South-Eastern Hospital at 2.45 p.m. that day.

On *January 10th* his sister, Mrs. H——, living next door, saw him for five minutes.

On *January 11th* his sister-in-law, Mrs. W—, who lives near, visited him for ten minutes. Patient's infection may have come from Erith, or possibly may have been conveyed by the sewage in which he works.

Exposure of others to Contagion from Patient.—As he works in different gangs with three others each on different days, there being three shifts of eight hours each per diem, at least nine fellow-workmen were exposed. Patient's initial illness being on *January 8th*, counting back twelve days would make his probable day of infection *December 27th*.

During part of the incubation period, for at least the last three days, all the nine men were exposed, and three of them for six hours on first day of initial symptoms, and three others for eight hours on second day of initial symptoms. His wife nursed him constantly up to the fourth day of the eruption.

The two children saw him daily up to within three hours before the appearance of the rash. His sister on the first day of the rash, and his sister-in-law on the second were briefly exposed.

The only one whom I could ascertain as having been infected was his wife, E. W., aged 40, who was exposed up to the fourth day. She was successfully vaccinated on *January 17th*, and on admission on *January 27th* there were four distended vaccination pustules on her left arm, surrounded by a ring of very minute variola papules. The small-pox eruption came out on *January 24th*, consequently she was vaccinated on the seventh day of the incubation period. On admission, her face was covered with very minute papules (about $\frac{1}{10}$ in. across) with a few larger vesicles. There were some on the trunk, and on the legs were extremely minute macules and a few papules. On *January 28th* (fifth day) the eruption on the face and arms is generally vesicular but still small. On the legs it is in the papular stage. E. W. shows well concurrent vaccination and small-pox, and the eruption seems like modifying.

2. T. A., male, aged 33, driver of a stationary engine, Westminster. Vaccinated in infancy. Discrete modified. *Initial symptoms*,—*January 7th*, pains in back; *January 8th*, eruption on forehead. Admitted *January 12th*. He works in a big smithy with 13 other men. On Sunday night (*January 8th*) at 8 p.m., he noticed two spots on his forehead.

Remained at his work till the night of *January 10th*; when, more spots appearing, he consulted a doctor, who thought he had chickenpox. Next day the doctor called again at 11 a.m., but would not give a decided diagnosis. The Medical Officer of Health was also doubtful on *January 11th*. On *January 12th* a Sanitary Inspector called to order his removal as a smallpox case; but patient not being satisfied with his dictum another medical man was called in, and pronouncing the disease to be smallpox patient was removed.

Up to this he slept with his wife, who is aged 30, vaccinated; and went to his work till the evening of *January 10th*. His three children, aged 8, 5, and 2, all vaccinated, saw him night and morning, the two eldest go to a neighbouring Board school. Two friends saw him, one for $1\frac{1}{2}$ hours just before the eruption appeared, the other for a quarter of an hour on the fourth day of the rash. A neighbour, heavily marked with smallpox, also "looked in."

In the same house as patient, there is a large workshop on the ground floor, where he is employed.

On the first floor, a long passage extends the whole length of the building; from this five separate tenements open, and patient and his family occupy the middle one.

In the attics there are two other tenements approached by a common stair. The occupants of the tenements, 40 in number, are continually passing by patient's door, but his children do not often play with the neighbours' children. None of the workshop people, besides himself, live on the premises; he is rent collector for the various tenements.

Exposed to infection from patient were:

a. His wife, who nursed and slept with him till the fifth day of the rash (removal).

β. Three children. Two saw him morning and evening, and one was constantly with him till his removal.

γ. Friend, who sat with him for $1\frac{1}{2}$ hours on first day of eruption.

δ. Friend who looked in for a quarter of an hour on third day.

ε. Old lady, marked with smallpox, visited him on fourth day.

5. Twelve fellow-workmen exposed till third day.

θ. Forty occupants of the tenements passing by his door.

T. A.'s probable manner of becoming infected is interesting:—

Next door to him, under the same roof, and occupying the adjoining tenement, are the G—— family.

One of them, a girl of sixteen, was laid up for three weeks at home with spots, which were supposed by her doctor to be chickenpox, but Mrs. G—— says the spots were exactly like T. A.'s. Five other members of the family had similar spots, and two of them (including the daughter mentioned above) went to their work with the eruption out on them.

Patient visited the G—— family on December 28th (10 to 11 days before his initial illness), and also on January 4th, for about half an hour each time, to collect the rents. He saw some of the children, but didn't remark any spots on them.

It is strange, if the G—— family were merely suffering from chickenpox, that it should have caused two of the workers to be laid up for some weeks; also

that T. A.'s incubation period should so exactly date back to a day when he visited them.

3. J. P., male, aged 46, from Lewisham, had a pretty severe discrete attack. Initial illness uncertain. Eruption, *January 6th* (morning), admitted *January 11th*. Vaccinated in infancy.

History of Exposure of others to Infection :—

In the same house live his wife, aged 40, vaccinated in infancy, revaccinated *January 12th*; she slept with her husband till *January 5th* (*i.e.*, night before eruption). Three children, 14, 11, and 5, two younger haven't been to school since Christmas; elder boy works at a laundress's, a few doors off, carrying clothes; he also goes out with a greengrocer's cart for the same employers.

A lodger has shut himself up since illness broke out in the house; he refuses vaccination.

Visiting J. P. were :—

E. W., married daughter, about 28, vaccinated in infancy, refuses revaccination. Lives at Deptford, but has seen her father constantly up to his removal.

M. A. P., married daughter, lives three doors off. Saw her father on second day for twenty minutes.

C. P., husband of above, saw patient several times, last on fourth day.

A. B., married daughter, and T. B., her husband, called with a friend (all three from Croydon) for ten minutes on fifth day.

In spite of inquiries, no cases have been traced to J. P.

4. *Nurse A.* was on night duty at an infirmary at the West End, in charge of two wards, each containing 40 patients. R. F., a tramp, came in on December 22nd, ill with smallpox, with the spots well out, from the adjoining casual ward where he had spent the night, and was put in Nurse A.'s ward till his removal next day (after being in the ward 22 hours).

For 12 hours during the night Nurse A. was exposed to infection, and for the remaining 10 hours of his stay two other nurses had charge; they were successfully revaccinated on December 24th.

G. S., about 40, the bathman, who washed R. F. on admission, says that he himself had a mild attack of smallpox when nine years old, he was vaccinated in infancy and successfully revaccinated about 15 years ago, so at the hospital he was selected as a "protected" person to disinfect R. F.'s clothes, but about a fortnight afterwards he developed a modified attack.

It was intended that Nurse A. should be revaccinated (she had not been vaccinated in childhood, and her vaccination six months ago failed), but by some mischance this was

omitted. Some of the patients in the two wards were considered to be too ill to be vaccinated, but most of those under 50 were done. At least a whole ward of 40 patients had been directly exposed for 22 hours, and there were no doubt nurses, ward-maids and convalescent patients capable of conveying infection to the other ward of 40, adjoining.

On *January 5th*, in the evening (*i.e.*, 14 days after R. F.'s admission) Nurse A. felt ill, with pains in the back, and the same evening she noticed two spots on her right arm. *January 7th* spots appeared on the face, and for these she consulted the matron, who thought they might be due to some medicine which she was taking for anæmia. All this while no one in the hospital seems to have remembered the case of R. F., who was diagnosed as smallpox before removal. On the afternoon of *January 7th* (*i.e.*, on the second day of the eruption), she went out with a friend from 4 till 7, visited a café at South Kensington Station for half-an-hour, about twenty people being in at the time; later, she went skating on the Serpentine. On *January 9th* smallpox was suspected by her doctor, she was isolated, and attended only by Nurse B. (who had smallpox seven years ago) until *January 11th*, when she was sent to the Ships.

During her illness, she met the ten other night nurses and the night superintendent at breakfast and dinner, attended each night to her eighty ward patients, and saw the two day nurses of her ward when going on duty, visited the matron several times, and slept in the same room as Nurse B. who alone looked after her from *January 9th* to *11th*. In this history there are two different exposures of infected persons to be considered:—

A. That of the casual R. F., during his stay in hospital (22 hours).

B. That of Nurse A. while she attended to her hospital duties up to the fourth day of eruption.

A. The exact period of R. F.'s eruption when he came to hospital is not known, but he was in the vesicular stage, so that it was probably about the third day of the rash.

Forty patients in one ward for 22 hours, two day nurses for 10 hours, one night nurse (Nurse A.) for 12 hours, a bathman, G. S., besides porters and ward-maids, &c., were pretty intimately exposed to infection; of these the night nurse (never successfully vaccinated) and the bathman and disinfecter, G. S. (? previous smallpox, and successful revaccination 15 years ago) were alone attacked, and got modified smallpox; revaccination seems to have prevented the two day nurses and the patients from taking the disease.

B. Nurse A. for four days of her eruption stood a good chance of infecting:—Her 80 patients, 11 night nurses whom she met at meal times, 2 day nurses when changing duty, and the matron, whom she visited constantly; but doubtless the revaccination of many of these after R. F.'s case must have been protective. Outside, there were her friend, and the 20 people in the café exposed on the second day. I leave out

of consideration the possible infection of Nurse B., who looked after her till the fifth day, as she had had smallpox seven years previously.

5. L. C., aged 20, ward-maid, hospital ships. Joined the staff on *December 9th*; vaccinated in infancy, four marks; revaccinated that day and three times subsequently, the last time being *December 19th*, and the only success. *December 24th* vomiting came on; *December 25th* patient felt rather worse; *December 28th* rash appeared. On admission she had a scanty eruption of papules, especially on her face and arms; but it modified very markedly. She went to her home in Kent on *December 25th*, and remained there till *December 29th* (second day of rash). Her father and mother were at home, also eleven brothers and sisters (one of whom is married and was present with her husband). They have all been vaccinated, and were revaccinated since patient's admission. There were no other visitors. Thus fifteen persons were exposed to infection up to the second day of the eruption.

L. C. got concurrent vaccinia and variola; the successful vaccination occurring on the fifth day of incubation. No further cases in her family.

6. A. M. B., female, aged 19, from New Cross, in with a severe discrete attack.

Initial Symptoms: *January 5th*, pain in limbs; *January 8th* (evening), eruption round the mouth. Vaccinated in infancy.

On Boxing Day (*December 26th*, 1892,) she rode in a tramcar from the "Lord Nelson" to New Kent Road, sitting next to her sweetheart's sister.

Opposite to them was a woman muffled up in a shawl, and patient noticed a peculiar heavy earthy smell about her (which she has since admission remarked in the wards); this woman is believed to have had "spots" on her face. P. T. (patient's "young man") was sitting on the same side of the car as this woman, but not very near her. They remained in her company for ten minutes, getting out early as they thought she had some "fever."

January 5th (ten days afterwards), patient felt ill with pains in the limbs, but continued at her work till *January 7th*, having to return home early that day on account of severe abdominal pain. She works in a large room with eight other girls, employed in re-lining quilts, and there is a suggestion that possibly her disease may have been caught from an infected quilt.

January 3rd she was at home, but at work from *January 4th* to 7th. On New Year's Day she went to a party at her sweetheart's home (three doors off), but didn't feel well at the time; she saw six persons of his family and about a dozen more, spending several hours in their company, and returning home late.

Her mother attended to her during her illness, and two brothers home from school and one sister were constantly with her till *January 7th* (the day before the eruption appeared).

Her sweetheart's mother and her own aunt (who has had smallpox) came to see patient on *January 10th* for five minutes. An occupant of the same house frequently

dropped in till *January 8th* to see her. This woman was vaccinated in infancy and revaccinated lately, and her two children have been revaccinated since patient's admission. A. M. B.'s two brothers and sisters have also been revaccinated. During her illness P. T. saw her on the day before and the day of the eruption; he was not feeling well at the time, and his eruption came out very shortly after hers appeared. She was removed on *January 12th* (fourth day of rash).

It seems probable that this ill-fated pair of lovers contracted smallpox from the woman in the tramcar, as their eruptions both came out between the thirteenth and fifteenth days after infection (if the woman's really was a case of smallpox); at any rate, they probably caught it together somewhere.

The persons exposed to infection from A. M. B. were:—

1. Her fellow work-women (eight in number), for three days at the end of the incubation period, and during most of the initial illness.
2. Eighteen people at P. T.'s house on sixth day of incubation.
3. Mother, constantly up to fourth day of the eruption.
4. Three brothers and sisters till evening before eruption.
5. P. T.'s mother and A. M. B.'s aunt for five minutes on second day of rash.
6. Lodger constantly till day of eruption.

Many of the persons exposed have been revaccinated; there have been no fresh cases as far as could be ascertained.

7. H. E., male, aged 23, plumber, from St. Pancras, modified discrete attack. Vaccinated in infancy. Initial symptoms, *December 27th*; eruption, *January 3rd*; admission, *January 7th*.

He worked last on Christmas Eve till 1 a.m. at one of the Bloomsbury squares, where he has been replacing closets in two houses for the past fortnight.

Dec. 27. Felt queer, with pains in his back and couldn't go out. *December 28th.* Remained at home till 6 p.m., when his master took him to the Empire Theatre, calling for a drink at a public-house off Leicester-square on the way home. That night he couldn't sleep, and next day, *December 29th*, while standing by the fire, he got giddy, lost his senses, fell into the fire, but was rescued from harm. *December 30th.* Didn't get up, having nausea, vertigo, and vomiting. Took some brandy and an aperient. Eruption didn't appear till the morning of *January 3rd*, he remaining at home more or less ill. At 6 a.m. on that day he awoke to find spots on his face, body, and legs. A doctor was called in, and diagnosed smallpox; but owing to some delay patient was not removed till *January 7th*. While ill he saw:—

1. His master, who called several times and saw him removed.
2. Five or six friends of his brothers from Huntley-street and Pancras-street came in for five or ten minutes two days before the eruption appeared.
3. His own family:—
 - a.* F., aged 9, schoolboy, saw him up till *January 7th*; attacked *January 17th*.
 - β.* A——t, aged 10, same exposure.

γ . A——r, aged 22, doesn't live at home, only spent a quarter of an hour in the house altogether on the second day of H. E.'s rash. These three all took smallpox; α 's being semi-confluent, β and γ having modified discrete. All the family were vaccinated in infancy; the rest have escaped.

ϵ . A——d, aged 19, slept with him nightly, and was in bed with him when the spots were first noticed. He goes to work at a builder's, doing outside and inside work in the company of several other men.

ζ . I., aged 13, who has just left school and got a job, saw him up to third day of rash; he doesn't live at home.

θ . Mother, who has had smallpox, attended him till fifth day.

ι . Sister, aged 15, was with him till his removal. She helps her mother at home. She had a vesicular skin eruption two months ago, and was in University College Hospital for three weeks, coming out a month before Christmas.

κ . C., brother, aged 18, doesn't live at home, is a plumber's improver; looked in to see how he was while the spots were out on the first day; also came in on third day.

There is no traceable cause of infection in this case: His sister's history looked suspicious at first, but she was discharged from hospital over a month before patient was attacked.

Patient managed to infect three of his brothers; the first two were exposed till the fifth day of his eruption, but the third, who doesn't live at home, had only a very brief exposure on the second day. It is certainly curious, after the above slight exposure causing infection, that the brother who slept with him till the morning when the rash was fully out should have escaped.

S. R. B., aged 32, builder. Mild discrete attack. Vaccinated in childhood, as was his wife. Is a rabid anti-vaccinator, so all his five children are unvaccinated. Works with three or four dozen men outside, bricklaying. During his illness, besides his own family, he was only seen by his wife's mother, who paid him a short visit.

He contracted the disease from his son H., a boy of eight, who had a severe discrete attack followed by conjunctivitis, keratitis, and ophthalmia of the left eye. The boy goes to a Board school at Peckham, and may have contracted the disease there, as there are other cases in the neighbourhood. For four days, during the eruptive period, the father stayed at home nursing his sick boy, and slept with him. Another brother who slept in the same bed as H. was not infected.

Thirteen days after the boy's illness, the father developed initial symptoms (pains in the back &c.); two days later there was great sweating and spots on the chest, so he walked up to the South-Eastern Hospital, where he was examined and detained as a smallpox case. It does not appear that any others of the family took the disease, or that it was conveyed to any of patient's fellow workmen. During patient's stay on the ships he heard, to his great indignation, that pressure having been brought to bear on his wife, his children were allowed to be vaccinated, but the vaccinations didn't succeed.

9. E. S., male, aged 32, came to the receiving-room of one of the London hospitals on *December 23rd* with a sore throat, and complaining of vomiting and pains in the back, and remained there for a quarter of an hour with five or six other patients. On *December 25th* he again attended, waiting in the same room for a quarter of an hour with six other patients. The eruption was then out, and the case was promptly diagnosed; he was temporarily isolated until his removal by the ambulance.

For some weeks he has been out of work, wandering about and sleeping in shelters and common lodging-houses. For eight or nine nights (the first of these corresponding to about the time when he was infected) he slept in a large dormitory, containing about 50 men, lying on mattresses close together and using the same towels, at the Salvation Army shelter in the Borough. The place was generally full, some of the men coming in for one night, others for several. Subsequent to this he spent one night at a shelter in Whitechapel, and just before admission passed two nights at one in Clerkenwell. While the rash was out he was wheeling about slop-clothes for some Jew clothiers in Petticoat Lane.

He thinks he has not been vaccinated; and has a severe discrete attack. At the hospital where he called there have been several cases of smallpox; but patient was only in the out-patient department for about half-an-hour altogether; besides when he first called he was already attacked with initial symptoms, and on the second occasion his rash was out. The possibilities of infection from this man are gigantic; but probably it will never be traced who got the disease from him, nor the still larger number who being exposed to infection escaped, owing either to vaccination at some time or other, or to their being exposed at an early and less infectious stage of the disease. As to personal insusceptibility, I believe it to exist, but it is too uncommon to require serious consideration. The several hundred men with which he must have come in contact at the three shelters during the 12—14 days before his eruption appeared, lying closely together in dormitories which can hardly be well-ventilated, their want and misery, and the too frequently inadequate sanitary arrangements of these places, present almost every possibility for the spread of the disease, especially as these men are too often unvaccinated, and wandering as they do from shelter to shelter carry in their filthy clothes the germs with which to set up a new nucleus of infection at the next shelter they come to. This man's carrying about slop-clothes with the eruption out on him must tend to the spread of infection wherever these clothes are distributed. It is quite conceivable that a sailor buying some of these clothes might develop the disease on board ship; and, unless isolated, might give it to the passengers and crew. On arrival in port the case if modified or overlooked might be the nucleus of an epidemic in the country.

10. E. M., male, aged 49, is an engineer and a "leading hand" at Woolwich Arsenal. He walks about the sheds superintending the men's work, but never remaining long anywhere, and his "beat" covers two miles.

Was vaccinated in infancy, and has a scanty discrete attack. On *December 20th*

his initial illness began, and he went home early, and hasn't been at work since; the rash came out on the 23rd.

During his illness he was only seen by two friends, an old sailor and a barber, who chatted with him for $1\frac{1}{2}$ hours on the 5th day, patient showing them his spots. His two children are vaccinated. The son, aged 19, works in the Arsenal as a machinist in a large shed in which are 1,000 men; he has continued throughout his father's illness at his work.

The daughter, aged 13, hasn't been to school for some weeks. About 12 days before his attack, patient's wife had similar spots on her face, ushered in by pains in the back; she is 49, not vaccinated since childhood.

Patient attributes his illness to his washerwoman, who does a good deal of washing for sailors.

There have been no further cases in patient's family, nor any infection, as far as I could gather, in the sheds where the son works.

11. W. B., male, aged 29, from Erith. Works as a stevedore for the P. and O. S.s. Co. at the Royal Albert Dock.

In his house live his wife, her seven brothers and sisters, and his wife's mother. Patient's wife was attacked with smallpox fourteen days before he fell ill, and he slept with her till her removal with a well-developed eruption (probably about the second or third day); she has a discrete attack. Patient works with gangs of eight men ashore or in a ship's hold, but he hadn't worked for a week previous to his illness. On the day he felt ill he went to work in the morning, but had to return home, when he vomited, and became delirious. His mother-in-law, who seems to have been a remarkably sensible woman, looked entirely after his nursing herself, turned the rest of the family out of the room, and hung up a carbolised sheet over the door.

He got a severe discrete attack. Since his removal, the rest of the family have been revaccinated, and so far I have heard of no further cases, but they had ample time to become infected before the illness of their sister (patient's wife) was recognised, and she was removed on the third day of her rash.

In the preceding cases I find, on summing up, that the following people were exposed to infection from the cases at various periods.

During the Incubation period:—

Three fellow-workmen of J. W.; 18 friends at a New Year's party by A. M. B.; and about 200 men who slept in the shelter with E. S.; in all 221 persons, in whom no attacks have so far as is known occurred.

In the Initial Illness:—

Two children and 6 fellow-workmen of J. W.; 3 brothers and sisters and 8 work-girls by A. M. B.; 6 friends of H. E.; 6 outpatients, and about 100 tramps in the

shelter with E. S.; 8 workmen by W. B.; and probably some hundreds (slightly) by E. M. (but these I shall disregard). Total, 139; no cases have been reported.

On the first day of Eruption :—

Sister of J. W., briefly; friend of T. A. for $1\frac{1}{2}$ hours; lodger by A. M. B. frequently; brother of H. E. slept with him; brother of H. B. had slept with him several nights; 6 outpatients for a quarter of an hour by E. S. Total 11; there have been no further attacks, in spite of two of the exposures being so intimate.

On second day of rash :—

Sister-in-law of J. W., briefly; married daughter of J. P., briefly; friend of Nurse A. and the 20 people in the café; 15 members of L. C.'s family, all revaccinated since her admission; A. M. B.'s future mother-in-law and aunt briefly; H. E.'s brother for quarter of an hour. Of these 40 people exposed only one, the last-named, is known to have become infected, and his exposure was very slight.

On third day of rash :—

Twelve fellow-workmen of T. A., and a friend, briefly. By R. F., forty inpatients in same ward for 22 hours, 2 day nurses for ten hours, 1 night nurse for 12 hours, and a bathman who washed him and disinfected his clothes. Of these the night nurse A., and the bathman were infected. Brother of H. E., briefly; brother of H. B., briefly. Total, 59 exposed, 2 infected. The escape from infection of the 44 infirmary occupants was probably due to their prompt revaccination.

On fourth day of rash :—

Wife of J. W., in constant attendance, infected; son-in-law of T. A. By Nurse A., 80 inpatients, 11 night nurses at meals, 2 day nurses briefly, and matron frequently; it is but fair to state that most of these had been revaccinated when R. F. was removed. Father of H. B., who nursed him and slept with him, and was infected; also his three brothers unvaccinated, and mother, vaccinated. Master of H. E. (revaccinated), constantly seeing him; 2 brothers (infected), sister, and mother (has had smallpox) of H. E.; 2 children of E. S., and two friends who came to see him; mother-in-law of E. M. Of these 112 (94 were recently revaccinated infirmary patients), 4 were infected.

On the fifth day of the rash :—

T. A.'s wife, who slept with him and nursed him, and 3 children less constantly exposed. Wife (recently revaccinated), 3 children, daughter on a visit (refused revaccination), married daughter, her husband, and a friend (these last three briefly) by J. P. Twelve persons, among whom, so far, no cases have arisen.

Altogether there have been at least 594 persons exposed (only 7 infected), some for long periods, extending from the incubation period to the fifth day of the rash. (This excludes the 40 tenement occupiers under T. A.'s roof, and the numerous work-

men slightly exposed by E. M.) 360 of these saw smallpox cases during the incubation and initial periods, all escaped. Up to the second day of the eruption, there were 51 exposed, and only 1 infected. After the second day there were 183 exposures (including 138 of the hospital inmates, mostly recently revaccinated; some of these are counted twice, as they were exposed to infection twice, first by R. F., the patient, and then by Nurse A.), and 6 were infected.

Excluding the 138 above-mentioned, there were 6 infections out of 45 cases; up to the second day only 1 out of 51.

Now what are the causes which might have protected these persons from smallpox besides (what I am contending for) the non-infectivity of the disease up to the second day:—

a. Personal insusceptibility; this exists in a small degree, but can hardly be demonstrated in this case.

b. Previous attacks of recognised smallpox (a few of those exposed had had the disease before).

c. Mild attacks of smallpox not recognised; these are often mistaken for chicken-pox, and doubtless have a considerable protective influence against future attack.

d. Vaccination in childhood. Most were vaccinated, but many years ago.

e. Recent successful revaccination (this was the case with over 100 of the hospital inmates).

f. Recent vaccination, though unsuccessful, is believed to be some protection.

Eliminating all these influences, there still remain sufficient to indicate that at least there is some truth in my proposal that smallpox does not become actively infective till about the second day of the rash, but this question requires more working out before it can be settled. Cases 10 and 11 were both infected by their wives; Case 1 gave it to his wife, whose probable infection was on the second day of his rash. Dr. Colclough in his interesting paper discusses the exposure of about 300 cases on the same lines, but he treats the matter more ably and fully than I have done; it was the reading of his paper which first turned my thoughts towards this subject.

III.—SPREAD OF INFECTION.

The ways in which smallpox contagion may be conveyed may be roughly divided into two groups.

A. By actual contact ; this includes contact with infected clothing and bedding, &c.

B. By air carriage ; this may be to a person in the same room, house, street, or neighbourhood ; and the dead may spread contagion as well as the living.

A.—1. *Persons sleeping together.*

This is most marked in the case of husband and wife ; but two brothers, or sisters, or friends, or anyone who sleeps with a smallpox patient is of course exposed to great risk. Here there is a maximum chance of becoming infected, and few persons who are thus exposed escape, unless protected by a previous attack of smallpox or by successful recent revaccination. A somewhat lesser form of danger is :—

2. *Occupying an infected bed.*

Dr. Birdwood, in the Guy's Hospital reports for 1891, relates an instance of a female child who was put into a bed lately occupied by a smallpox patient ; she complained that there were crumbs in the bed ; but these, in all probability, were smallpox crusts. Her body, clothed in a tight-fitting woollen singlet, escaped, but her limbs, face, and neck, in contact with the bedclothes, were covered with a profuse discrete rash. This is one of the cases he cites in support of his theory, of which I shall speak later.

3. *Wearing infected clothes.*

An example of this occurs in the Hospital Ships Report for 1885, showing the mischief done by a careless anti-vaccinator. Three of his children were down with smallpox, and one died ; he had been looking after them, but refused to allow any to be revaccinated or removed ; he borrowed a black suit of clothes from a neighbour to attend the child's funeral, and on returning it conveyed infection to several members of his neighbour's family.

4. *Clothes sent to the wash,*

from an infected house, especially if used by the sick person and of woollen material, are a fertile source of infection; and it is little wonder that laundries occasionally spread this, as well as other infectious diseases, or that laundrymaids do not always themselves escape infection.

A case arose in Lambeth of a boy who, fetching his master's clothes to a laundry, whence the mistress had been removed with smallpox, conveyed the infection home to his own family, of which four other members besides himself took the disease. From the cases which arose in early 1892 at the French hospital, the disease spread to two laundries, affecting several of the girls, and they conveyed it to other places in Hoxton and Shoreditch.

Considering the manner in which bedding (especially mattresses and blankets) retains the germs of contagious disease, the following may be looked upon as a triumph of disinfection. During the smallpox epidemic of 1885-6, over 10,000 patients were removed from the hospital ships and located during their convalescence, *i.e.*, during the highly infectious scabbing stage, in huts at the smallpox camp which was erected for the purpose at Gore Farm. Most of the things they used, mattresses, clothes, bedding, &c., were thoroughly disinfected by being subjected directly to steam in a Lyon's disinfector for over an hour at a temperature of 250 deg. F.; boots, furs, feathers, hats, &c., being exposed only to dry heat in the same apparatus.

In 1890 and 1892, the larger number of scarlet fever cases in the Metropolitan Asylums Board's hospitals necessitated the employment of Gore Farm (where a permanent hospital had been erected) for the accommodation of scarlet fever convalescents. Identically the same beds, bedding, clothes, &c., as had been used for the smallpox cases and disinfected were now used for the scarlet fever convalescents, and although the hospital has been running now for over two years altogether, and sometimes there are as many as 800 patients in at once exclusive of any staff, there has not arisen, during the whole of this time, one single case of smallpox at Gore Farm.

5. *Infected rags, &c., from abroad*

have before now spread smallpox. There was a suspicious case of this kind in Shoreditch in 1892, but the evidence was not conclusive.

6. *Nurses and others of the Staff of a Smallpox Hospital;*

convalescent patients, and visitors may convey contagion to others, though they may not themselves contract the disease, but on the hospital ships the regulations as regards disinfection are so stringent, that in the course of nearly ten years I have only been able to discover a single case of infection from such

a source. The nurses mostly sleep on the administrative ship, the *Endymion*, and they are allowed to have no shore clothes aboard. When they want to go out, their ward clothes are removed in one room, they then pass into a bath-room, where they have a carbolic soap bath (including washing their hair), thence they pass into dressing-rooms, where their outdoor clothes are kept in lockers, and being dressed, they leave the premises at once.

The case I allude to was one in which a nurse, having thoroughly disinfected herself, was preparing to go out, when she was momentarily recalled to her ward. She again bathed and changed her clothes, but it was not considered necessary for her again to wash her hair. She went home, and slept in the same bed as a sister, who was home for the day, and after the usual incubation period, this sister developed symptoms of smallpox, and came aboard as a patient.

B.—*Air-carriage of Infection.*

1. The carrying of the smallpox infection for some distance by the air may be said to have been clearly shown by the investigations which led eventually to the closing of the Metropolitan Asylums Board's Hospitals at Fulham and Hampstead for smallpox cases, and resulted in the establishment of the almost perfect isolation of the hospital ships in Long Reach.

In the Hospital Commissions Report for 1887, Dr. Power, Local Government Board Inspector, gave exhaustive evidence on this point. Considering the Fulham Hospital as a centre, he drew imaginary circles of a quarter, a half, three-quarters, and one mile radius round it, and found about three times as many smallpox cases in the inner quarter, as in the circle just outside this. He also divided his circles into quarters, and considering each with reference to the wind that prevailed at the time, he found by far the greatest number of cases in the segment corresponding to the direction of the wind; thus with a N.W. wind there were most cases in the S.E. corner of the inner quarter-mile circle, and so on. To guard against error he collected for some years the cases, or, as he preferred to take it, the "houses attacked," before and after the establishment of the hospital for smallpox cases, and found a vast increase in the later years.

At Hampstead, though the researches were not so elaborate, it was pretty well shown, to mention merely one point, that in a long row of houses just outside the hospital boundary there had of late been one or more smallpox case in nearly every house which was occupied, while for years before this there were only a few isolated cases cropping up now and then in the whole parish.

Contrasting with the above may be mentioned the experiences of the hospital ships. On the southern or landward side there is not a house for nearly a mile; about half a mile off near the other shore is moored the "*Cornwall*" training ship. In the summer

of 1892 a boy aboard caught smallpox, but this could hardly be traced to air-infection from the ships, considering that the "Cornwall" lies close to Purfleet, in which there had lately been smallpox cases. The statement made by a man that his son became infected with smallpox from collecting driftwood from the Thames, a mile or two below the ships, may be dismissed as absurd. Since the establishment of the ships at Long Reach during the epidemic of 1885-6, no case of air-infection has ever been traced to their influence.

2. Of course those who enter a room or ward in which smallpox patients are, are exposed to the air contagion of smallpox, even though they may not go near the patient, or touch anything infected; for the air of such places, even with the best ventilation, contains in its dust minute fragments of contagious particles (hair, skin, dried scabs, &c., and probably infected gaseous material) which may convey smallpox to the visitor. A good example of this is shown in one of the cases under "histories of exposure," where a young man merely took a look at his sick brother on the second day of eruption, and was not in the house for more than a quarter of an hour, yet he contracted the disease.

3. *Sanitary men*, when disinfecting rooms, &c., whence smallpox patients have been removed, are exposed partly to contagion from handling infected articles, and partly to air-infection from being in an infected atmosphere.

Two such cases have come within my own knowledge.

In one, a disinfecter had to do a small close room from which a married couple had been taken away with smallpox. He removed his hat and coat while at work as the room was so hot. Fourteen days later symptoms of smallpox appeared in him. He attributed his infection to the fact of his removing his hat, and that he did not follow his usual rule of smoking after the job was finished. Previously, he had done a considerable amount of similar work, escaping unscathed.

The second case is one of a disinfecter who took his son, a boy of fifteen, to see him at work. The father discussed the diagnosis of the case which had gone to hospital with the woman of the house, and came to the conclusion that a mistake had been made. After the usual incubation period the son got discrete smallpox, and subsequently conveyed the infection to two of his young brothers. The family consists of five members, all vaccinated in infancy, and the disease was modified in the two younger boys.

4. While air, by dilution, readily destroys the efficiency of the contagion, yet if the smallpox virus be excluded from the air it may retain its infectivity for years. A friend of mine unfortunately fell a victim to this fatal property. He was English chaplain at Rosario, in the Argentine Republic, and in the course of his work had to superintend some exhumations in a cemetery where the victims of a smallpox epidemic, eight years previously, had been interred. He was attacked with the most virulent form of hæmorrhagic smallpox, and died in three days.

5. Those recently dead of smallpox may infect persons who go near the bodies. A case is quoted by Curschmann, in Ziemmsen's "Encyclopædia of Medicine," in which four medical students went to see a smallpox corpse; all four contracted the disease, and yet only one of the number had touched the body.

6. Sailors from abroad (especially Spain, Turkey, and India), often introduce smallpox into London, but owing to the vigilance of the medical officers of health, especially of recent years, these cases are usually isolated at once, and spread no further.

7. Tramps, as I have endeavoured to show in the histories of exposure to infection, belonging as they do to an ill-fed, and often unvaccinated class, sometimes spread smallpox broadcast; and in the present epidemic of 1892-3 in London (which threatens to assume alarming proportions, there having been over 100 cases in the last two months), a large proportion of the cases are men out of work, who have been living a hand-to-mouth life, and sleeping for weeks in shelters.

IV.—ANALYSIS OF 302 CASES.

302 consecutive cases, many of which I have seen at various stages of their illness, admitted to the ships during about ten months in 1892, comprised the following :—

Smallpox cases	Vaccinated in infancy-	231	} or 82·98 per cent. of the smallpox cases.	
	„ later in life	5		
	Vaccination doubtful -	10	or 3·55	„
	Unvaccinated including 2 inoculated - -	36	} or 12·77 „	
		282	100	„
Not Smallpox	Other diseases - - - -	-	-	14
	Doubtful smallpox - - - -	-	-	5
	Child admitted with its mother - -	-	-	1
				20

Thus of 302 cases admitted, 282 only were cases of smallpox.

Now, the best modern authorities on the subject tell us (*vide* Dr. Ogle, Mr. Thorne Thorne, and Sir John Simon, in Report I. of the present Vaccination Commission) that the vaccinated represent 95 per cent. of the population; of the total attacks, in this analysis, only 82·98 per cent. were amongst the vaccinated (or over 12 per cent. less than their ratio to the general population).

Out of 282 smallpox cases there were 28 deaths, or a general death-rate of 9·9 per cent.

Among the 234 vaccinated (including 5 unsuccessful ones) there were 16 deaths, or 6·8 per cent. (including 1 unsuccessful case).

In the unvaccinated—out of 36 cases there were 11 deaths, or 30·6 per cent.

Thus, though the unvaccinated were only 12·77 per cent. of the total smallpox cases, they contributed 39·28 per cent. to the death-rate.

Of the two cases inoculated in childhood, one, a male, aged 57, never vaccinated, a heavy drinker, died of confluent smallpox followed by pneumonia on the tenth day. The other, a woman aged 57, was inoculated at 10 years of age, vaccinated (for the first time) unsuccessfully the day her initial symptoms commenced, and had a

greatly modified attack—there being only three discrete spots altogether. As she was known to have lived for some time in the midst of a centre of infection, this looks very much as if she received some protection from the vaccination, though unsuccessful.

Out of the ten doubtful cases only one death occurred; this was a confluent attack with convulsions, cerebral and abdominal symptoms, in a man of 31.

Now, comparing the severity of the attacks in the vaccinated and unvaccinated:—

a. As to the Stay in Hospital.

The unvaccinated recoveries averaged 43 days' stay.

The vaccinated recoveries averaged 30 days.

Or, in other words, the vaccinated got well in a month, while the unvaccinated took six weeks.

β. Severity of the Attacks.

Of the 36 unvaccinated cases.....19 Confluent (2 H'ghc) or 52·8 per cent.

15 Discrete (1 H'ghc) or 41·67 per cent.

2 Discrete (mild) or 5·53 per cent.

Out of 234 Vaccinated cases41 Confluent (5 H'ghc) or 17·53 per cent.

86 Discrete { including 9 } or 36·75 per cent.
 { severe cases }

87 Discrete modfd. or 37·18 per cent.

20 „ { gtly. mdfd., } or 8·54 per cent.
 { sparse or }
 { scanty }

Thus over 94 per cent. of the unvaccinated had severe attacks to 54 per cent. of the vaccinated.

In over 45 per cent. of the vaccinated the disease was either partly or greatly modified.

γ. Comparing the Age-Incidence—viz., the frequency of attack and fatalities at different age-periods—in the vaccinated and unvaccinated, we get the following:—

	UNVACCINATED.				VACCINATED.			
	Cases.	Percentage to total cases.	Deaths.	Percentage to cases at this period.	Cases.	Percentage to total cases.	Deaths.	Percentage to cases at this period.
Below 1 year	4	11·11	2	50	1	·44	0	0
Between 1—5 years.....	12	33·34	8	66·6	13	5·58	3	23·07
„ 5—10 „	5	13·88	} no deaths.		19	8·15	} no deaths.	
„ 10—15 „	6	16·68			35	15·02		
„ 15—20 „	3	8·34			54	23·18		
„ 20—30 „	5	13·88			54	23·18		
Above 30 „	1	2·77	1		57	24·45	10	17·5
	36		11		233		16	

The figures in the above tables, it may be reasonably urged, are too small for statistical purposes, but at least they serve to show one or two important points, which are borne out by larger collections of statistics.

1. That in the unvaccinated the largest number of cases and deaths occur up to the age of 5 years.

2. That in the vaccinated the cases increase progressively as the age does. This may be taken as evidence that the vaccination protection wears off in the course of years.

3. That the death-rate in the vaccinated is almost the highest at ages over 30—in large collections of statistics it is the highest. In this small table two deaths of infants of 16 and 18 months of confluent smallpox caused the death-rate from 1-5 years to be highest.

δ. In considering the comparative prevalence of the various initial symptoms, the vaccinated and unvaccinated, discrete and confluent, are classed together—for, except in the marked severity in the pains in the back which occurs in most confluent cases, there are no especial distinctions.

Indeed, some of the mildest cases of varioloid are ushered in by symptoms the severity of which are out of all proportion to the disease which follows.

Initial Symptoms Tabulated.

Out of 280 cases (234 vaccinated and 36 unvaccinated) 94 are not particularized, leaving 186 which are.

In these—

Headache occurs in	-	-	-	-	148 cases
Backache	„	-	-	-	120 „
Vomiting	„	-	-	-	69 „
Nausea	„	-	-	-	20 „
Pains in the limbs occurs in	-	-	-	-	56 „
Shivering	„	-	-	-	49 „
Rigors	„	-	-	-	14 „
Sore throat	„	-	-	-	22 „

Of the less common symptoms are:—

Initial rashes occur in	-	-	-	-	*14 cases
Abdominal pain	„	-	-	-	3 „
Pain in chest	„	-	-	-	1 „
Convulsions	„	-	-	-	2 „
Colic	„	-	-	-	1 „
Diarrhoea	„	-	-	-	1 „
Catarrh (nasal)	„	-	-	-	2 „
Fretfulness	„	-	-	-	3 „
Faintness	„	-	-	-	1 „
Vertigo	„	-	-	-	1 „
Delirium	„	-	-	-	1 „

* Of these 4 were Erythematous, 3 were Scarlatiniform, 2 were Macular (one becoming Petechial), 1 was Morbilliform, 2 were Petechial, 1 Petechial Macular and Erythematous, and 1 was simply described as an Initial Rash.

Thus the most frequent symptoms are Headache, Backache, Vomiting, Pains in the limbs, and Rigors or Shivering ; and two or three of these usually occur together. The attack is usually ushered in by Rigors or Shivering, and Vomiting most often occurs on the second day.

ε. The *Complications* in the two classes are as under :—

	UNVACCINATED. 36 Cases and 12 Deaths, leaving 24 Survivors.			VACCINATED. 234 Cases and 16 Deaths, leaving 218 Survivors.		
Delirium occurred in	-	3	-	-	22	
Abscesses	„	-	5	-	7	
Boils	„	-	2	-	7	
Conjunctivitis	„	-	8	-	14	
Keratitis	„	-	2	-	1	(Interstitial.)
Corneal Ulcer	„	-	3	-	5	
Hypopion	„	-	1	-	0	
Tinea Tarsi	„	-	0	-	1	
Phlyctenulæ	„	-	1	-	4	
Sub-conjunctival						
Hæmorrhage occurred in	0	-	-	-	1	
Pneumonia	„	1	-	-	0	
Bronchitis	„	0	-	-	3	
Laryngitis	„	2	-	-	0	
Nasal Catarrh	„	1	-	-	1	(Severe)
Otorrhœa	„	0	-	-	2	
Sore Throat	„	1	-	-	7	
Swollen Glands	„	0	-	-	1	
Nausea	„	0	-	-	1	
Dysphagia	„	1	-	-	1	
Vomiting	„	0	-	-	1	
Diarrhœa	„	0	-	-	2	
Labial Herpes	„	0	-	-	1	
Pemphigus	„	0	-	-	4	
Joint Inflammation	„	0	-	-	1	(Hæmorrhagic case)
Convulsions	„	1	-	-	0	
Great Restlessness	„	1	-	-	0	
Coma	„	1	-	-	0	

Considering that the vaccinated survivors are rather more than nine times the number of the unvaccinated ones, their comparative freedom from complications, especially eye-troubles, abscesses, and boils, is worthy of notice.

Next, considering the *Revaccinations*.

Of these there were 18 some time previously to the smallpox attack; 15 were successful

Of *Recent Revaccinations* (i.e., shortly before and during the attack).

Out of 65 cases, there were 23 successes and 42 failures.

During the Incubation period.

Eighteen cases succeeded. Most of these were done more than six days before the Initial Symptoms; but in one case only one day before.

Three were failures: one 17 days before the Initial Symptoms, one seven days before, and one the day before.

In the Initial Stage.

On the day symptoms commenced two of the revaccinations were performed:—

1 failed, and

1 succeeded, but the patient developed a confluent attack.

After the Appearance of the Eruption.

Out of 41 cases all failed but two, and these were doubtful.

This indicates that revaccinations during the incubation period generally succeed; after symptoms have developed their success is doubtful, and after the appearance of the rash they almost invariably fail.

From the hospital case-sheets I have also drawn up a statement, endeavouring to show how the protective action of vaccination wears off as years go on. No account is taken of the patient's age, but the cases are arranged simply in decennial periods, showing the time which elapsed since their last successful vaccination, the nature of the cases which occurred, and the rate of deaths to cases in each group.

Periods elapsing between the last successful Vaccination and the Patient's attack of Smallpox, and the effect on the Disease.

BETWEEN 1 DAY } AND 1 MONTH }	Cases 22	including	Deaths 2	One of confluent in a baby of 18 months old, attacked 4 days after vaccination, and One of hæmorrhagic in a child of 16 months, attacked 1 month after vaccination.
Recoveries 20, all Discrete cases,				
being 1 Discrete (abundant)				
2 Discrete				
1 „ (with petechial eruption)				
14 „ modified				
2 „ greatly modified				

BETWEEN 1 MONTH AND 1 YEAR there were no cases.

BETWEEN 1—10 YEARS, 30 CASES AND NO DEATHS.

Of these 2 Confluent

10 Discrete

13 „ modified

5 „ greatly modified.

FROM 10—20 YEARS, 83 CASES (1 DEATH).
 Including 2 Hæmorrhagic (1 death)
 8 Confluent
 36 Discrete
 31 „ modified
 6 „ greatly modified.

FROM 20—30 YEARS, 49 CASES (3 DEATHS).
 1 Hæmorrhagic (died)
 9 Confluent (2 died)
 23 Discrete
 14 „ modified
 2 „ greatly modified.

FROM 30—40 YEARS, 33 CASES (4 DEATHS).
 12 Confluent (4 deaths)
 13 Discrete
 7 „ modified
 1 „ greatly modified.

OVER 40 YEARS, 20 CASES (3 DEATHS).
 6 Confluent (3 deaths).
 6 Discrete.
 6 „ modified.
 2 „ greatly modified.

From the above cases I have made up the following Tables :—

A., as showing the progressive rise in the death-rate as age advances, due to the gradual wearing off of the influence of the vaccination protection.

B., indicating a concomitant fall in the number of the modified cases.

TABLE A.								
Time after last successful Vaccination.							Death-rate.	Cases.
Between 1 day and 1 month	...	...	...	...	...	...	9·09 per cent.	in 22
1 month to 1 year	...	...	...	...	...	...	no cases.	
1—10 years	...	...	...	...	...	...	None	in 30
10—20 years	...	...	...	...	...	...	1·2 per cent.	in 83
20—30 years	...	...	...	...	...	...	6·1 per cent.	in 49
30—40 years	...	...	...	...	...	...	12·1 per cent.	in 33
Over 40 years	...	...	...	...	...	...	15 per cent.	in 20

The two deaths which cause so high a death-rate between one day and month after vaccination occurred in children of sixteen months and eighteen months old respectively.

TABLE B.								
MODIFICATIONS OF THE ERUPTION AFTER SUCCESSFUL VACCINATION.								
Between 1 day and 1 month	...	...	...	...	72·7 per cent.	with modified discrete eruption.		
1 and 10 years	...	...	...	...	60	„	„	„
10 and 20 years	...	...	...	...	44·5	„	„	„
20 and 30 years	...	...	...	...	32·6	„	„	„
30 and 40 years	...	...	...	...	24·2	„	„	„
Over 40 years	...	...	...	...	40	„	„	„

I cannot explain how it is that among those over forty years after vaccination there should be so large a percentage of modified eruptions, but it is certain that in some few cases after only one vaccination any attack of smallpox, however long after it occurs, assumes a modified form.

CASES NOT HAVING SMALLPOX ON ADMISSION.

Comprised—

Varicella ...	...	12	{ (6 of these were infected with smallpox and 1 died ; 3 caught scarlet fever.)
Febricula ...	...	5	
Purpura ...	...	1	(3 infected with smallpox.)
Secondary Syphilis	...	2	(got discrete smallpox.)
Doubtful	5	
Tinea	1	
Nil...	...	2	(1 child admitted with its mother.)

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Below I give a brief account of their vaccinations.

Varicella, 12 cases.

Escaped Smallpox, 3.

1. Successfully revaccinated 5 days after varicella eruption.
2. Successfully revaccinated 10 days after varicella eruption,
and 6 days after varicella eruption—failed.
3. Successfully revaccinated 8 days after varicella eruption,
and 2 days after varicella eruption—failed.

Infected Aboard, 6.

1. Successfully revaccinated 16 days before smallpox eruption began—*i.e.*, 2 days before the incubation period. Modified discrete attack.
2. Unvaccinated in infancy (and not vaccinated at ships by some error) ; æt. 2 ; got a confluent attack with hæmorrhage into the vesicles, coma, and died on ninth day.
3. Successfully revaccinated 11 days before smallpox eruption—*i.e.*, on third day of incubation ; got a modified discrete attack.
4. Revaccinated 8 days before eruption—failed
4 days before eruption—succeeded } modified discrete case.
5. Revaccinated twice aboard ; both failed ; æt. 1½ years. Child was last successfully vaccinated in infancy. Very modified discrete.
6. Brother of 5. Twice revaccinated aboard ; both failed ; æt. 3 years. Last successfully vaccinated in infancy. Initial erythematous rash and modified discrete (put down to influence of carbolic soap).

In spite of their having such slight rashes that Dr. Birdwood did not consider them to be suffering from smallpox, 5 and 6, on going home, managed to infect their mother, who was afterwards admitted to the ships with a modified discrete eruption. Cases 1, 3 and 4 are examples of concurrent vaccinia and variola.

Caught Scarlet Fever, 3.

1. Revaccinated day after admission (May 31st), also on June 4th ; both succeeded. On June 4th scarlet rash and throat symptoms developed.
 2. Revaccinated twice ; once 8 days before the fever—failed.
and once 4 days before the fever—succeeded.
 3. Revaccinated twice after admission ; both failed ; æt. 3½ ; vaccinated in infancy.
- Cases 1 and 2 are instances of concurrent vaccinia and scarlet fever.

Febricula, 5 cases.*Escaped Smallpox*, 2.

1. Revaccinated twice aboard ; 1st failed, 2nd six days after appearance of rash—succeeded.
2. Revaccinated twice after admission—both failed.
Æt. 8 ; last successful vaccination in infancy.

Caught Smallpox, 3.

1. Revaccinated 24 days before smallpox eruption—failed.
13 days before smallpox eruption—succeeded.
(i.e., on second day of incubation period).
Modified discrete attack.
2. Revaccinated 20 days before infection—failed. Very modified attack, only three spots.
Last successful vaccination 21 years ago.
3. Revaccinated unsuccessfully 12 days after admission
Got modified discrete smallpox.
Last successful vaccination 12 years ago.

Purpura, 1 case ; *infected on the ships*.

Came in with abundant pink hæmorrhages on the face and soft palate. The eruption lasted till October 9th. On that day a macular erythema (initial smallpox rash) developed on the chest and abdomen. On October 11th papules appeared, and the axillary rash became petechial. October 13th vesiculation occurred. The attack was a modified discrete one. Patient had been unsuccessfully vaccinated on September 23rd and 27th ; but on October 2nd it succeeded. Thus this patient commenced with purpura, and part of the time had concurrent purpura and vaccinia, and also incubating variola, which continued its course with the vaccinia after the purpura had passed away.

Secondary Syphilis, 2 ; *both escaped Smallpox*.

1. Revaccinated twice with final success 10 days after the development of the sore throat, and 7 days after the syphilitic eruption appeared.
2. Revaccinated twice on ships—first failed.
second succeeded.

In case 2, the assistant medical officer who saw the case on admission told me that the eruption on the face looked extremely like smallpox.

The above two cases were both relieved by pot. iodide. In them there was evidently concurrent syphilis and vaccinia.

Nil cases, 2 ; *neither infected*.

1. An infant of four months was admitted with its mother, who had a discrete attack. It was successfully vaccinated six weeks before its mother took ill. It continued suckling, and escaped attack.
2. Boy, æt. 3 ; revaccinated on ships twice—both failed ; had a scabbing papule on his shoulder, which only lasted two days. His sister is aboard with discrete attack.

Tinea circinata, 1 case.

Came from same street as infected P. Revaccinated day after admission successfully. A papular vaccinia eruption appeared $\frac{1}{3}$ inch from the vaccination site.

Of the Doubtful Cases, 5.

1. Successfully revaccinated 7 days before initial symptoms. Was exposed to infection 10 days before rash came out (arms). Rash was probably a vaccinia eruption, though the vesicles round the scars looked very much like those of varioloid.

2. Sister to above, aged 8. Vaccinated in infancy—not revaccinated. She had a discrete papular and vesicular rash, scanty on the face; very abundant but undersized on the backs of the arms.
3. Had 8 pimples (papules) and vesicles altogether; these were not characteristic.
Revaccinated on 15th day of eruption—failed.
Æt. 26; last successful vaccination in infancy.
4. Papular eruption on palms of hands and between fingers.
Revaccinated on 2nd day of eruption—success.
5. Revaccinated 8 days before initial symptoms—success.
Had also tinea tonsurans.

London Outbreak of 1891-2.

Smallpox commenced in November, 1891, at a Swiss club near Fitzroy Square, where for about a month its presence was undetected. Thirteen persons, including several of the waiters, were attacked between December and March.

In St. Pancras parish, three-quarters of a mile off, there were ten cases from February to April, and five at a public-house close to Euston Station; northward, three got the disease in Kentish Town Road.

The house physician at the French Hospital had been laid up in January and February with smallpox, three patients took it, the hospital was closed, and by means of infected clothes there was a spread to two laundries in St. Giles' and Limehouse, where six cases occurred.

A patient in a model dwelling in Holborn was the cause of an outbreak in Bethnal Green (seven cases from March to May), and in another part of Holborn there were four cases in May and June. At New Inn Street, Shoreditch, there were twenty-two cases from February till May, and at a neighbouring model dwelling (Rodney Buildings) a lame girl who was thought to have chickenpox spread the disease to twenty-one persons (mostly under the same roof) in April and May; her sister, who was not attacked, probably conveyed infection to an artificial-flower maker's in Hoxton, and eight cases resulted. Near Rodney Buildings there were six cases off Kingsland Road, and five in Old Street. Old hair brought from a dealer's in Shoreditch is believed to have originated six cases in Hatton Garden; and at a Spitalfields cigar-factory eight persons got smallpox in May; this is likely to have caused the three cases at the London Fever Hospital. From an infected laundry keeper in Lambeth arose eleven other cases in May and June. Besides the above there were isolated cases in Westminster, Fulham, Southwark, and other parishes which could not be grouped; also a few cases of infection from abroad by sailors. Outside the metropolitan area twenty-six cases came from Stone and three from Erith to the Ships. For about two months (in August and September) there was a lull, no fresh cases coming in, and only five patients being left on the Ships, but in October an outbreak occurred in Islington and fourteen cases were admitted, also five from the London Hospital (infected through a ship's steward lately home from Smyrna).

Altogether there were about 350 smallpox cases at the Ships in 1892.

V.—GENERAL REMARKS.

In the following, I venture to allude to some points of interest which have attracted my notice.

1. *Dr. Birdwood's Theory of Smallpox.*

Most authorities consider the smallpox contagion as a zymosis—*i.e.*, the virus finds its way into the body, probably by inhalation through the lungs, makes its way into the blood, which it poisons, and causes such changes therein as results in the production of the characteristic eruption and consequent symptoms.

In the Guy's Hospital reports for 1891, Dr. Birdwood, for nearly nine years medical superintendent at the hospital ships, and who has seen over 13,000 cases, puts forward an ingenious theory.

He considers the contagion as a surface mycosis, and compares its distribution on the skin to that of the dust as seen on the bodies of sweeps and coalheavers. The body being hotter than the external air, heats the air around it beneath the clothes; this expands, escapes, and its place is taken by the colder external air bringing with it the dust, and, according to Dr. Birdwood, the smallpox germs in those exposed to them.

The conjunctivæ, even of a coalheaver, remain free from dust, and usually from smallpox germs (unless the infection is conveyed from pocks on the lids); this is due to the protective action of the eyelashes, which act as filters. The mouth, larynx, and trachea, which are in free contact with the air, suffer from the eruption, while the œsophagus, which is a closed tube except during the act of swallowing, escapes. More eruption is usually present on the back than on the chest, as the clothes fit looser there; while on the abdomen, where the clothes are tightest, there is rarely much eruption, except when the patient has been infected while in bed. Dr. Birdwood maintains that the smallpox germ settles on the skin, gradually works its way through the superficial layers until it comes to a capillary, in which it sets up irritation, which leads to coagulation in the vessel, exudation, and the gradual formation of a papule. This, he thinks, takes up the whole of the incubation period. He explains the initial symptoms by saying that the functions of a portion of the skin being in abeyance, more waste material than usual is thrown into the blood, and, reacting on the nervous centres, causes the fever and pains. In the cases of sleeping in a infected bed, I have already given Pr. B.'s example of a girl whose body, covered with a tight woollen

garment, completely escaped, though her limbs and neck were covered with eruption. Length of exposure determines the amount of the eruption, and thus the severity of the attack; this happens even in those cases which have been revaccinated after exposure, these get concurrent vaccinia and variola.

In a person exposed for a lengthened period, or having several successive exposures, Dr. B. thinks that successive crops of pocks follow; this would account for the pocks in various stages of development, papular, vesicular and pustular, occurring together in the same part of the body. An individual idiosyncrasy (tendency to the hæmorrhagic diathesis) is held by Dr. B. to account for the petechial and purpuric rashes.

In both inoculated smallpox and concurrent smallpox and vaccination the general eruption may be as abundant as in the most severe confluent case; it is all a question of exposure.

It would take longer time than is at my disposal, and a much greater experience of smallpox than mine, to attempt at all thoroughly to either support or confute Dr. Birdwood's theory. I will content myself with giving very briefly what seem to me the arguments for and against it.

For.—1. The abdomen, the part most closely covered up, usually escapes.

I have seen a case which supports this statement in a remarkable manner. A girl, who wore a long-waisted corset, came in with no eruption on her abdomen; on her back, where the corset fitted looser, there were a few spots; on her arms, legs, and upper chest, right to the edges of the corset, there was a most profuse eruption.

2. Where the patient is attacked in bed, there is more eruption than usual on the abdomen. I have seen such cases, but I have also seen others in which the patient's infection could only be traced to some time when he was up and about, and yet there was a free eruption on the abdomen.

3. Points of pressure, where the skin is irritated, afford a ready entrance to contagion; and garter marking, places where ill-fitting boots press, straps round the waist in men, and braces, generally mark the site of a plentiful eruption.

Against.—1. According to Dr. Birdwood's theory, those parts which are covered up should be free, or almost free from eruption; yet I lately saw a case of a man with a varicose ulcer of the leg, whose wound had been kept carefully bandaged, and only dressed with some antiseptic solution once a day, yet around the edges of the actual wound (which part was also included in the bandage) there were far more pocks than on the corresponding part of the other leg.

2. A child was born aboard the ships with a smallpox eruption out on it; and a second child developed the eruption of smallpox two or three days after birth (far too soon for its developing an eruption had it been infected after birth). I cannot see how Dr. Birdwood's theory of skin mycosis can explain the above cases.

It would be a cause for much congratulation to every one if his theory were true; for immediately after exposure to infection, a person would only have to submit to a hot bath containing some antiseptic, and he would at once remove all traces of contagion.

2. *Growth of the Pocks from day to day.*

While in residence at the ships I measured daily for five days an area of $1\frac{1}{2}$ inches by 1 inch on the forearm of a man with a discrete attack in the vesicular stage.

I found that the growth of the individual pocks increased in about the following ratio :—1st day, $\frac{1}{20} \times \frac{1}{20}$ inch ; 2nd, $\frac{1}{20} \times \frac{1}{10}$ nearly ; 3rd, $\frac{1}{10} \times \frac{1}{10}$; 4th, $\frac{1}{10} \times \frac{1}{5}$ nearly ; 5th, $\frac{1}{5} \times \frac{1}{5}$. At first the vesicles were translucent, then an opaque spot appeared in the centre of each, which spread outwards until the whole vesicle-wall had become opaque, the whole process lasting about three days. During the translucent stage the contents of the vesicle were clear serum ; this gradually became more turbid, until, when the outer wall was quite dull, it had become ordinary pus.

3. *Formation of the Areola.*

Round the papule there is a slight areola, this gradually grows as the pock becomes vesicular, and if several vesicles are close together their areolæ may run together and become confluent. The areola is distinctly raised as well as reddened. The greatest size and brightest redness of the areola occurs when the vesicle has just become pustular, and for a short time afterwards, then it gradually lessens, and becomes livid in colour ; and in the late pustules with shrunken walls which linger round the wrists and ankles there is little or no surrounding areola.

3. *Umbilication.*

This has often been considered to be one of the most marked features in a smallpox case ; it certainly often occurs, but not with unvarying frequency, and few if any cases show it in all the vesicles.

I have noticed it most marked in those cases of modified smallpox in which the vesicles, never becoming very full, finally dry up without proceeding to pustulation. The surface of the papule is flat or somewhat rounded, the early vesicle often shows the cup-shaped central depression of umbilication, while the mature vesicle and early pustule are tense, and have a hemispherical outline ; later, the absorption of the contents taking place, the late pustule has shrunken walls, and, if it has not previously burst, dries up and scabs.

4. *Two varieties of Skin Affection in the late stages of Smallpox,*

I have occasionally noticed; I refer to the so-called pemphigus and variola verrucosa.

The pemphigus blisters, thin-walled and containing a clear, straw-coloured fluid, are very superficial; they are present in the late pustular stage. Often they occur between the pocks, but sometimes a large blister surrounds a small group of two or three pustules and raises them up with it, and the individual pocks can be seen through its thin wall. That a pemphigus blister is quite different from a small confluent smallpox patch is evident from the thinness of its walls, and from the fact that on being pricked it at once collapses, exuding, not pus, but a clear watery fluid.

After the blisters have burst, they often leave superficial ulcers, and as their thin walls dry up and scale, an appearance of psoriasis is given, particularly as they occur on the extensor surfaces of the limbs near the wrists and ankles.

Sometimes on the face, especially on the nose, when there has been a thick eruption, and pretty deep pitting is left, the parts of the skin which have been left free seem to undergo a hypertrophy, and small fleshy projections like filiform warts are left between the depressions. I am unable to say if these remain permanently or not, but if they did they could easily be snipped off and the base cauterised. Some persons, long after all the scabs have fallen off, suffer very much from acne pustulosa on the face, especially round the nose; this bears a great resemblance to the condition which is present in some cases of eruption in the modified disease; I refer to those, mentioned among my cases, in which acuminate papules are found, the tip of which alone becomes first vesicular and then pustular.

5. *Position and distribution of the Rash.*

It usually commences on the face, mostly on the forehead; but may be first seen on the wrists. It gradually spreads, soon to the arms and body; but appears two days later on the legs than on the face. On the back it may generally be found; and sometimes on the palate, when there is little elsewhere. Its thick distribution on the neck and shoulders, also round the waist, on the limbs, also the presence of pocks (which may be felt before they are seen) in the palms and soles, are points of importance in diagnosis. It is remarkable how often the abdomen almost or completely escapes, and this is certainly a point in favour of Dr. Birdwood's theory.

6. *Swelling of the Face and subsequent Pitting.*

Dr. Birdwood thought that the pitting after smallpox being largely due to the antecedent swelling; if he could prevent the swelling, there would be no pitting.

Looking round for various astringents, he at last hit upon Aromatic Chalk Powder. This is made into a paste with water, and painted on the face, three times a day for a week. At first it smarts very much, and in any case completely obscures the course of the disease, prevents ordinary evaporation going on from the skin where covered, and certainly adds to the patient's repulsive appearance. At one time I certainly thought that it modified the disease by hastening the exudation and consequent scabbing; but, having lately seen several cases in which one-half of the face only had been painted, I have been unable, after careful observation, to detect any appreciable differences between the two sides.

Underneath the large scabs formed by the exudation and paint crusts, it is conceivable that superficial suppuration and ulceration may be going on on a large scale unknown to the medical attendant.

7. *Scabbing*

in most parts of the body is a superficial process, and the rounded brown crusts come off pretty easily, leaving shallow dark-red depressions (unless there has been deep ulceration), which remain for about two months. There is some slight desquamation after the removal of the crusts. But it is in the palms and soles, beneath the thick epidermis of these parts, that the scabs remain latest; and patients on the Ships are not allowed to go home until these are all out, so the epidermis has to be opened with a needle and the scabs picked out. Sometimes in severe confluent cases large flakes peel off the palms and soles, bearing on their under surface the dried-up pocks; rarely the nails are shed.

8. *Eye Troubles.*

Careful nursing and cleanliness save many eyes in smallpox. It is rare for there to be any vesicles on the ocular conjunctiva; but there are frequent pocks on the lids. The lids, often enormously swollen, are glued together by a muco-purulent secretion, which if not frequently removed by syringing, gives rise to conjunctivitis and all its attendant evils.

The eyelids must be separated, regardless of the patient's feelings on the subject, and a saturated solution of boracic acid thoroughly well syringed under both lids. This requires to be done constantly, and if the patient persists in rubbing his sore eyes, his hands must be muffled.

In conjunctivitis, atropine and iced compresses are of use, also the yellow oxide of mercury ointment (which is on the Ships made up with cocaine). In keratitis and corneal ulcer, weak nitrate of silver solutions (2 grains to the ounce) are beneficial.

9. *Effects of Smallpox on Menstruation and Pregnancy.*

From inquiries made from nurses at the Ships and also from the patients themselves, I find that almost always as soon as a woman gets the initial symptoms of smallpox, or at any rate early in the disease, a period comes on. This may or may not coincide with her regular time. Usually she loses more blood and the period lasts longer.

Generally a pregnant woman aborts as soon as she gets smallpox; as in the case of a woman with the disease delivered prematurely, the child was not marked at birth, but two days afterwards a confluent rash came out and it died.

The following are exceptional:—1. A woman on the “Atlas,” four months gone, had a severe unmodified confluent attack with pemphigus; she went on till the eighth month, when she was delivered of a dead child. 2. Another infected case, in the seventh month, went on uninterruptedly to full term.

10. *Protection from recent Successful Revaccination.*

During Dr. Birdwood’s time as medical superintendent of the hospital ships, over 700 people have been employed as members of the staff (viz., from June 10th, 1884, to August 27th, 1892); and among these there have only been three definite cases of smallpox.

11. *Appearance of a Confluent Eruption.*

A smallpox rash rarely becomes confluent until the closely-set vesicles grow so as to merge together. Throughout this paper I have considered the term “confluent” in the manner in which it is used by Dr. Birdwood—viz., only when confluent patches occur on the face, and then not unless a considerable part of the rash is confluent.

In some varieties, the face is so closely covered by an eruption of small papules, that it looks uniformly swollen, and it is by the hand rather than by the eye that the slight irregularities of the surface can be detected.

In others, the vesicles instead of forming hemispherical elevations, as they do when discrete, run together into large flat-topped masses, and these over a considerable area of the face present the appearance of a parchment mask.

12. *Effects of Pressure or Injury on the Eruption.*

Those persons who have had a good deal of walking to do usually have a plentiful eruption in the soles of the feet. The pressure-points of tight boots are seen in the increased eruption round the ankles, over the heels, along the inner side of the foot, and on the dorsum of the toes, where confluent masses often form and cause troublesome

sores. A tight garter will often cause a confluent band round the leg. Over the hips where corsets rub, the eruption is profuse; and a similar effect is produced by the belt worn by many working men. The rubbing of braces shows its effect by an increased amount of eruption over the shoulders, and a tight collar by a closely-set often confluent rash on the sides of the neck and beneath the angles of the jaw. On the mark of a mustard plaister put on in the incubation period there is an increased eruption; if it be applied later no effect is produced. Recent wounds have often a confluent patch round their edges; while on a varicose leg I have noticed hæmorrhages into the vesicles from the venous congestion. Curschmann relates one case of a man with pediculi, whose scratches were covered with a row of vesicles "like pearls on a string."

Lately I came across an interesting case at the Ships. A tramp, chopping wood for a week in a casual ward during his incubation period, rested his left forearm on his left thigh to steady the wood. On each of these two parts (which he told me had got red and sore from his work) there was a confluent patch about 3 inches by 2. Getting him to place his arm over his leg in the position mentioned, the two patches corresponded.

13. *The Protective Influence of Good Vaccination Marks.*

Although there is little doubt that persons with good marks enjoy, if not absolute immunity, at least considerable protection against smallpox attacks, there is always the difficulty of determining what constitutes good marks. Dr. Gayton, who analysed 10,403 cases, in giving evidence before the present Royal Commission on Vaccination, said that he considered all marks with an area of over .5 square inches, entirely foveated, as "good"; below this came the class of "imperfect marks," while those stated to have been vaccinated, but showing no marks, are classed as "vaccination nominal." He obtained the following results, taking the deaths per 100 attacks at all ages:—

Good marks	...	...	...	...	4.25 per cent.
Imperfect marks	...	...	...	...	10.45 „
Vaccination nominal	...	...	...	...	28.33 „
Not vaccinated	...	...	...	...	41.4 „

14. *The "Nature" of an Attack as affecting its method of Transmission.*

Dr. Colclough has directed my attention to what he considers to be an almost universal fact—viz., that a person exposed to infection from a mild case often gets confluent smallpox; while one infected from a confluent case usually contracts a modified form. The explanation of this is that the smallpox virus in a confluent case has worn itself out on the person attacked, while in a mild case its potency is so little diminished that it is capable of giving rise to the severest forms of the disease. Although I have seen some cases which bear out this theory, my knowledge of smallpox is not extensive enough for me to thoroughly substantiate it; still, it seems feasible.

VI.—CONCLUSIONS.

1. Unmodified smallpox is almost always severe, more often than not confluent, frequently fatal; and even in the cases that do not die, complications generally occur and convalescence is prolonged. The pocks are large and mostly uniform in size, and all, or nearly all of them go through the various stages (papular, vesicular, and pustular).

2. In modified smallpox, (for which vaccination may fairly claim the greater amount of credit) the spots are generally less in number, smaller, not uniform in size, and the greatest part abort either in the papular or vesicular stage. The general disturbance is not so great, the disease is rarely fatal, and recovery is more rapid, complications being unusual. It is in this kind that the largest number of varieties both of the general disease and of the eruption occur. The range extends from slight malaise and fever lasting for 2-3 days, the so-called "variola sine variolis," (and which is really the initial symptoms only), to a severe discrete form, generally occurring many years after vaccination, and really very little removed from an unvaccinated case.

3. The severity of the attack is not to be measured by the acuteness of the initial symptoms, for I have seen some mild varioloids ushered in by rigors, delirium and a temperature of 104 deg. Severe and persistent backache is said to foreshadow a confluent attack.

4. Primary vaccination only protects for a limited and variable time; the average being considered to be 10-15 years; but Dr. Birdwood recommends revaccination every 2 years in all persons exposed to contagion.

5. Revaccination, if recent and successful, is usually protective; but Dr. Colclough collected 22 cases of concurrent smallpox and revaccination, in all these the attack was modified. In this paper I have also mentioned several similar cases. Even unsuccessful revaccination (that which doesn't produce a characteristic vesicle) appears to modify the disease sometimes.

6. Smallpox contagion may be conveyed by the air, by clothes and bedding, by a person who escapes, by corpses, and in many other ways, and it lasts for years if excluded from the air.

7. Besides vaccinia, other acute specific diseases, such as varicella, scarlet fever, and purpura, may occur concurrently with smallpox.

8. Acute specific diseases, occurring together with smallpox, generally delay the progress of the eruption; this is also the case in purpura variolosa.

9. It seems from the cases quoted, and Dr. Colclough's researches on the same subject, that smallpox is not actively infective during the incubation or initial periods nor does it become so until the second day of the eruption.

10. The longer and more intimately a person is exposed to contagion, the greater is likely to be the amount of his eruption, and consequently the severity of his attack.

11. Vaccination having been shown to be an ineffectual protection after an uncertain number of years, and successful revaccination being almost protective for life, the employment of the latter should be made compulsory (as it is in the German army, Sweden, &c., with excellent results). To make this more efficient it should be done every seven years; and with efficient isolation and disinfection, I venture to think that smallpox would never become epidemic, at least in this country. Isolation and disinfection are of special importance in the cases of smallpox imported from abroad, in order to prevent its spread.

12. In a case of doubtful eruption it is always best to vaccinate the patient; for, if vaccination be successful, it is almost an absolute proof that the disease is not smallpox.

13. So few medical men have the opportunity of seeing cases of smallpox, that wrong diagnoses are frequently made; and I think the present medical student might with advantage to himself and to the community attend for a month at a smallpox hospital, in addition to the fever instruction now made compulsory by so many of the universities and licensing boards. The dilemma in which a medical man finds himself in seeing a case of doubtful smallpox is this:—If he fails to recognise the case as smallpox, the patient remains as a source of infection to those around him. If, on the other hand, he diagnoses as smallpox some other disease, the unfortunate patient is isolated, and exposed to the risk of catching smallpox. In either case the doctor's position is an unenviable one.

